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LAKE CLASSIFICATION. A TROPHIC CHARACTERIZATION OF WISCONSIN LAKES

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The design and application of the Lake Condition Index (LCI) system of classifying lakes is described, and it is demonstrated that lake classification can be employed as a useful tool by resource managers for comparing the trophic condition of large numbers of lakes. The LCI system was generated when an evaluation of other systems revealed that most are presently unsuitable for classifying the vast majority of lakes because the analytical data required for their use are lacking. Utilizing subjective information, the LCI system was applied to the classification of more than 1100 large Wisconsin lakes. Checks of the results show that 86% of the lakes were appropriately classified within the limits of the system; 14% were misclassified, as judged by individuals familiar with the lakes in question. Most, but not all, discrepancies were due to erroneous input data.

The LCI values obtained were coupled with nutrient-loading considerations and shoreline density-development factors to demonstrate that lake classification can serve as a workable data base for lake renewal and management programs. The LCI system is easily modified to incorporate additional data for special purposes. The system could be used to classify an estimated 70-80% of the larger lakes in the United States.

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CONTENTS

Page

Abstract ii

List of Figures. iv

List of Tables v

Acknowledgments. vi

Sections

I Conclusions and Recommendations 1

II Introduction. 3

III Lake Classification Methodology 7

IV Data Acquisition. 23

V Trophic Characterization of Wisconsin Lakes 37

VI Lake Classification for Decision Making . 57

VII Regional Application of the LCI System. . 72

VIII References. 78

IX Appendices. 81

LIST OF FIGURES

Page

1. Frequency Distribution of Lakes by Condition Index for Four Areas of Wisconsin. 44

2. Frequency Distribution of Wisconsin Lakes According to Condition Index 46

3. Distribution of Surface Area of Wisconsin Lakes as a Function of Condition Index . . . 47

4. Average Surface Area of Wisconsin Lakes as a Function of Condition Index 48

5. Distribution and Average LCI of Wisconsin Study Lakes - by County. 49

6. Dissolved Oxygen Conditions in Wisconsin Lakes. 52

7. Calculated Condition Indexes for Three Types of Wisconsin Lakes 53

8. Relationship between Nutrient Loading and Lake Condition (Hypothetical Data) 62

LIST OF TABLES

Page

1. Water Quality Scores for 10 Michigan Lakes. 12
2. Fifty-Five Florida Lakes Ranked According to Trophic State Index (TSI). 14
3. Composite Rating of 12 Wisconsin Lakes. . . 16
4. Classification of 7 New Zealand Lakes . . . 19
5. Summary of Systems to Classify Lakes According to Trophic Status 21
6. Summary of Lake Inventory Data. 24-25
7. Availability of Water Quality Data for Lakes 26-27
8. Point System for Lake Condition Index . . . 37
9. Comparative Rank of 12 Wisconsin Lakes. . . 42
10. Summary of Classification System Review by Wisconsin DNR Area Fish Managers 55
11. Specific Loading Levels for Lakes Expressed as Total Nitrogen and Total Phosphorus in $g/m^2/yr$ 60
12. Development Density of Wisconsin Lakes. . . 69
13. Applicability of Lake Classification System 75

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Considerable advice and input was received from faculty members of the University of Wisconsin, and a great deal of help was received from the staff of the Water Resources Center in preparing the manuscript.

SECTION I

CONCLUSIONS AND RECOMMENDATIONS

Based on a review of lake classification methodology, the development of a technique for calculating Lake Condition Index values, and the use of that technique to classify more than 1100 lakes in Wisconsin, it is concluded that:

1) Lake classification is a valuable decision-making tool that could be used to great advantage for lake management purposes.

2) Sophisticated lake classification systems requiring multiple water quality parameters cannot be used to classify most lakes at the present time because the necessary input data are lacking. Compilation of the necessary input data is likely to be required as a part of most large-scale classification efforts.

3) The methodology of calculating Lake Condition Index values presented in this report provides a basis for classifying lakes in the absence of detailed biological and chemical data. Necessary input information can be compiled without resorting to extensive field investigations. The system is flexible and can be modified to incorporate additional data input for special purposes.

4) Computed LCI values are accurate to approximately ±2 units and give a workable basis for comparing water quality in lakes as judged by individuals familiar with subsets of the lakes classified.

5) Many of the benefits of lake classification as a decision-making device could be achieved by the implementation of intrastate classification systems. Some additional advantages would result from the use of a single system on a regional or national basis.

6) It is estimated that the LCI technique could be used to classify about 70% of the larger lakes in this country and, with some modification, could probably be used to classify an additional 12% of the lakes larger than 100 acres (40 ha).

7) Ultimately, it would be desirable to classify lakes on the basis of repetitive field data. As an interim step, classification systems of the type presented here can and should be used to attain many of the practical benefits of lake classification.

SECTION II

INTRODUCTION

The literal definition (from Webster) of classification and its processes refers to a systematic, orderly arrangement of things in groups or categories according to established criteria or presumed relationships. Classification is an activity which has engaged man, consciously or subconsciously, throughout his existence with systems ranging from simple categorizations (edible *vs* inedible) to complex academic exercises (taxonomy of the earth's flora and fauna). The motivations for classifying a body of subject matter can be numerous and varied, but during the course of this project two general purposes appear behind most classification schemes:

1) The size and scope of the subject matter preclude consideration as a whole, and classification into subsets is necessary to create comprehensible units.
2) The subject matter is poorly understood and classification is used as a dissection tray for examining and evaluating the "working parts" of the unit.

In the first case, the classification serves as a tool, but usually becomes an end in itself, with categories undergoing relatively little change or modification while serving to orient and guide the user through an otherwise hopeless bulk of material. Again, the notable example of this form of classification is the taxonomy of plants and animals. With well over 650,000 species listed in the class *Insecta* alone, the establishment of systematic zoological categories is essential to the perspective and understanding of the inquirer.

In the second case, however, the classification process serves primarily as a tool and may only have incidental value as an end product. As an example, we can use the subject of this study, the classification of lakes. While a definitive, comprehensive classification of waters would be desirable, there seems to be little immediate hope of achieving such a goal because:

1) both the quantity and quality of pertinent, comprehensive data are lacking;
2) many of the physical, chemical, and biological mechanisms of aquatic environs are but vaguely understood, if at all; and
3) the diverse pressures and special interests competing for water and its use dampen the probability that one all-purpose classification system will satisfy all points of view.

The fact that these difficulties exist, however, does nothing to mollify the need for methods to assess a critical and limited resource which is so easy to degrade and so difficult to restore. Therefore, classification is needed here, particularly as a tool or device for assessing undesirable trends in the environment and as a platform for administrative decision-making. These needs are specifically recognized in Section 314(a) of the 1972 Amendments to the Water Quality Act, which states that,

> "Each State shall prepare or establish, and submit to the Administrator for his approval:
>
> 1) an identification and classification according to eutrophic condition of all publicly owned fresh water lakes in such State;
> 2) procedures, processes, and methods (including land use requirements) to control sources of pollution of such lakes; and
> 3) methods and procedures, in conjunction with appropriate Federal agencies, to restore quality of such lakes."

At the state level, Wisconsin has enacted the Public Inland Lake Protection and Rehabilitation Act. This legislation, which became effective in June, 1974, established a state-local program to:

1) compile background information on Wisconsin lakes;
2) define problems where they exist and identify their cause(s);
3) consider appropriate protective and remedial steps to confront problems;
4) delineate feasible courses of action; and
5) implement the protective or corrective measure.

In order to fulfill federal and state water quality requirements and enable agencies to manage lakes efficiently and effectively, it is essential that methods be developed which allow an overview of resource conditions and elucidate appropriate management options. To this end, one of the specific goals of the Lake Inventory Project was to compile an information base for lakes and to develop a system for classifying them--the information base as the start of a flexible, multipurpose data core, and the classification system as a contributor to management's overview. From the outset, the lake classification objective was viewed from a nationwide perspective, with the goal of developing methodology for assessing the trophic character of the nation's lakes. Thus, the efforts were shaped by the practical realities and constraints of geographical diversity, data availability, as well as the vaguely-defined classification parameter, trophic status.

This report provides an assessment of the country's lake data base and a review of the published lake classification systems which have been used to classify lakes according to trophic conditions. Based on this information, a lake classification method requiring minimal data input was developed and tested by classifying all Wisconsin lakes larger than 100 acres (40 ha). This latter activity was undertaken as a pilot project to evaluate the benefits that could be obtained from a broad-scale classification effort. Other reports generated by this activity include:

> Wall, P. J., M. J. Ketelle, and P. D. Uttormark. Wisconsin Lakes Receiving Sewage Effluents. Technical Report 73-1, Water Resources Center, University of Wisconsin, Madison, Wisconsin, 1973.
>
> Ketelle, M. J. and P. D. Uttormark. Problem Lakes in the United States. Project #16010 EHR report for the Office of Research and Monitoring, Environmental Protection Agency, 1971.

In developing the background information for this project, one report, "Classifying Water Bodies: Feasibility and Recommendations for Classifying Water" (Aukerman, R. and G. I. Chesley, 1971), stood apart from the rest because of its broad, philosophical approach to the topic. Aukerman and Chesley addressed the questions, "Should lakes be classified?," and if so, "How should this be done?" It was concluded that lakes should definitely be classified because the perceived advantages--as viewed by individuals responsible for a broad spectrum of water-related activities--clearly outweighed potential disadvantages. The ten advantages cited by the authors stressed the potential uses of lake classification in the planning aspects of water resource management, namely:

designation for optimum use,
guidelines for allocation,
guidelines for orderly development,
guidelines for zoning and control,
protection of the physical resource,
environmental quality protection,
protection of fisheries and wildlife resources,
protection of human health and safety,
preservation of the resource, and
orderly growth and development of lands adjacent to water.

The disadvantages associated with classification were not as obvious as the advantages. The two limitations cited were: 1) the misconceptions which may arise from a poorly designed system, and 2) the static nature of predetermined classes which are often inappropriate for evaluating changing resources, technologies, and social demands.

Thus, potential disadvantages were envisioned if improperly designed classification systems were used; however, with careful planning and design these shortcomings can be avoided. The desirability of maintaining flexibility within classification systems appears to be particularly well taken. Classification is likely to be most useful if it is viewed as a decision-making tool which is subject to continual update and revision to incorporate new information or to address changing needs.

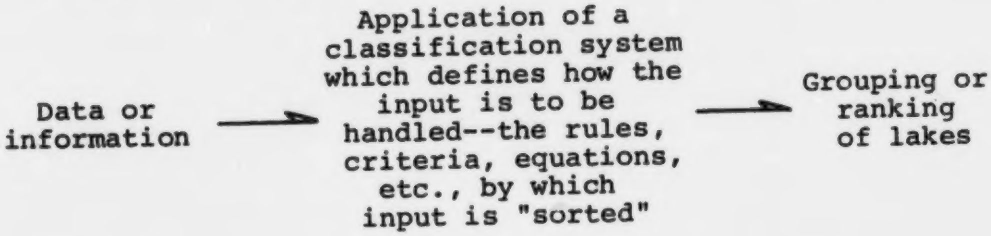
Aukerman and Chesley did not present specific methodology for classifying lakes; however, their presentation of classification concepts and their discussion of the inadequacies of static classification systems were useful in designing and carrying out this project. Throughout this report, attempts are made to demonstrate the advantages gained when lake classification is viewed as a flexible, dynamic aid for evaluation, rather than a static, pre-set method for making small groups out of large ones.

SECTION III

LAKE CLASSIFICATION METHODOLOGY

Classification as an aid for establishing broad-based priorities is not only advantageous, it is an essential undertaking. The concept that "each lake has its own unique personality" has its place, but it provides little help to the administrator who must allocate funds and manpower to areas of critical need. Some method of "lumping" lake characteristics must be used. If an administrator had to read a detailed description of each and every lake in his district before making a decision--and in many cases there are hundreds of lakes--he would probably resort to a dart board as his prime decision-making tool.

For purposes of this report, lake classification is viewed as an activity consisting of three components--input, processing and output. Or, in slightly more detail, lake classification may be described by a flow diagram such as,


Data or information
Application of a classification system which defines how the input is to be handled--the rules, criteria, equations, etc., by which input is "sorted"
Grouping or ranking of lakes

This provides an operational definition which is used in this report, i.e., classification systems are rules, criteria, guidelines or equations by which lake information or data can be manipulated to yield a grouping or ranking of lakes. Obviously lakes can be classified in an almost endless variety of ways, depending on specific interests or concerns.

Primary emphasis here is placed on systems which relate to the trophic character of lakes, particularly with regard to the need, priority, and potential for rehabilitation or the need and urgency for protective action to prevent imminent degradation.

The definition of lake classification given above provides one method of comparing and analyzing classification systems. The following terminology is used:

Types of input:	data - Objective input, numbers or values determined by measurement.
	information - Subjective input, descriptions or assessments of conditions which may or may not be based on documented evidence.
Types of output:	grouped output - Lakes having similar characteristics are organized in distinct groups. There is no hierarchy of lakes within groups; they are simply different from one another. (Example: Output consisting of wild lakes, general recreation lakes, development lakes, and urban lakes.)
	ranked output - Lakes are ordered relative to one another with respect to some scale of reference.
Types of systems:	relative systems - Lakes are classed only with respect to one another, either by similarities or differences. Ranks and groups are defined by the input set, and the classification of a particular lake may change if additional lakes are classified.
	independent systems - Lakes are classified according to criteria which are not dependent on the classification of other lakes in the data set. It is possible to select a single lake and classify it with systems of this type.
	analytic systems - Combinations of parameters and the formation of groups are based on statistical or other numerical methods (i.e., correlations, cluster analysis, etc.).
	empirical systems - Parameters are combined on an intuitive basis or boundaries of groups are defined arbitrarily.
	pre-set systems - Number and characteristics of groups are specified from the outset, and

classification is accomplished by matching the characteristics of a given lake to those of the predefined groups.

post-set systems - Groups or ranks are formed from analysis or treatments of lake data.

The above definitions are useful for analyzing classification systems, but it should be recognized that the definitions are not mutually exclusive--a particular system may involve a combination of the identified input, output and processing types. Also, in some cases the distinction of one type over another is not clear-cut. For example, a system may be designed to classify several hundred lakes according to their potential for additional recreational development based on an integer scale from one to ten. Since many lakes would have the same scale-value, and these subgroups would have no internal hierarchy, this could be viewed as a grouping system. However, based on the gradation of groups with respect to a common scale of reference, this could properly be considered to be a ranking system. This latter view is most consistent with the philosophy of this report.

PRE-SET GROUPING SYSTEMS

In systems of this type, the number of groups to be formed and the characteristics of each group are specified at the outset. Classification is accomplished by comparing the characteristics of each lake to those of the predefined groups. Thus, an original set of lakes is divided into "homogeneous" subsets.

Simplicity is both the strength and weakness of pre-set grouping systems. Useful systems can be devised which require minimal data and, in some instances, subjective information can be used when data are lacking. However, the objective for classification must also be simple so that logical groups can be defined which 1) include all the combinations represented by the set of lakes to be classified, or 2) are mutually exclusive so that a specific lake "fits" into only one group.

Pre-set grouping systems can be used effectively for some types of regulatory lake management. For example, different boating regulations could apply to lakes depending on their classification based on size and depth. Outboard motors could be prohibited on all small and/or shallow lakes; an intermediate group could be defined on which motors would be permitted, but at controlled speed or horsepower; high-speed activities could be permitted only on large, deep lakes. The terms "large," "small," "deep" and "shallow" must be quantified to apply such a system, but this could most likely be done without difficulty.

The example illustrates the type of situation for which pre-set grouping systems are most applicable:

1) Classification is done for a single purpose (boating regulation).
2) The number of groups to be formed is readily established in advance.
3) Each group is defined in a mutually exclusive manner so that a given lake would fit in only one group.
4) There is a logical, though perhaps arbitrary, distinction between groups that is consistent with the overall objective of classification.

For the most part, pre-set grouping systems are not readily applicable to classifying lakes according to trophic status or water quality consideration because it is extremely difficult to define distinct groups. Trophic status is generally viewed as a continuum extending from oligotrophy to eutrophy with no interim breakpoints. One exception to this generality is presented by Zafar (1959). As part of a general system designed to provide a worldwide, taxonomic description of lakes, he expanded on the earlier work of Strom (1930) and suggested that Pearsall's basic ratio, (Na+K)/(Ca+Mg), could be used to separate lakes into three basic trophic groups (ratio is based on equivalents).

Trophic state	Pearsall's ratio
Basically eutrophic	Less than 1.2
" mesotrophic	Between 1.2 & 2.0
" oligotrophic	Greater than 2.0

These three groups were then further subdivided by considering the concentrations of N, P, and humus. The subdivision of "basically eutrophic" is given below where (+) and (-) refer to rich and poor, respectively.

Basically Eutrophic

α-eutrophic	+ N, + P, + humus
β-eutrophic	+ N, - P, + humus
γ-eutrophic	+ N, + P, - humus
δ-eutrophic	+ N, - P, - humus
ν-eutrophic	- N, + P, + humus
λ-eutrophic	- N, - P, + humus
μ-eutrophic	- N, + P, - humus
π-eutrophic	- N, - P, - humus

from Zafar (1959)

An identical breakdown is given for basically mesotrophic and oligotrophic lakes. The terms "rich" and "poor" were not quantified by Zafar, and the system has not been tested to establish its general validity or usefulness. It is interesting to note that eight subgroups were defined to cover all possible combinations of the three parameters without regard to whether or not all combinations exist in nature.

The worldwide taxonomy of lakes presented by Zafar was intended as the basis for a standard vocabulary among scientists. The intent was to give lakes descriptive labels which depict their trophic character. Because of differences in purpose and objectives, this system is not directly applicable to assessments of lake protection and renewal. However, if utilized in the manner intended by Zafar, the system could help to clarify scientific communication dealing with limnology.

POST-SET SYSTEMS

Techniques for calculating indices of trophic status from mathematical equations are reported by Newton and Fetterolf (1966) and Shannon and Brezonik (1972). In each case, the objective was to develop an equation which combined several indicators of trophic condition to yield a composite "score" for any given lake. Parameters (independent variables in the equations) were selected which, based on the judgment of the investigators, were indicative of general water quality conditions in the lakes.

Newton and Fetterolf computed "chemical water quality evaluation scores" using the equation,

$$\text{Score} = 2.(\text{OP}) + 0.1(\text{COD}) + (\text{ON}) + (\text{NH}_3)$$

where OP = soluble orthophosphate concentration in mg PO_4/l
COD = chemical oxygen demand in mg O_2/l
ON = organic nitrogen in mg N/l
NH_3 = free ammonia in mg N/l

For all parameters, the values inserted in the equation are the sum of surface concentrations and hypolimnetic concentrations (upper hypolimnion for lakes deeper than 40', lower hypolimnion for shallower lakes).

No information is given regarding the rationale for selecting the coefficients in the equation, except that "each factor was weighted to adjust for its relative importance in lake water qualtiy."

Data were collected for 10 lakes in Michigan and the lakes were ranked as shown below.

Table 1. WATER QUALITY SCORES
FOR 10 MICHIGAN LAKES

Lake	Score	Rank
Chemung	8.7	5
Crooked	8.7	6
Fenton	4.5	1
Lobdell	4.7	2
Ore	12.3	7
Ponemah	21.0	9
Potter	22.2	10
Silver	4.8	3
Squaw	13.3	8
Woodland	7.4	4

from Newton and Fetterolf (1966)

The results were judged by the authors to give a reasonable portrayal of the relative water quality in the 10 lakes.

A somewhat different approach was used by Shannon and Brezonik (1972). They approached the idea of "trophic state" as a multidimensional concept that cannot be measured directly or considered realistically on the basis of individual trophic indicators. In this case, indicators of trophic state are combined through treatment with multivariate statistical procedures to yield algebraic expressions for computing "trophic status indexes" for lakes. Separate expressions were developed for clear and colored lakes, as given below.

For clear lakes:

$$\begin{aligned} \mathrm{TSI} = {} & 0.936\left(\frac{1}{\mathrm{SD}}\right) + 0.827(\mathrm{COND}) + 0.907(\mathrm{TON}) \\ & + 0.748(\mathrm{TP}) + 0.938(\mathrm{PP}) + 0.892(\mathrm{CHA}) \\ & + 0.579\left(\frac{1}{\mathrm{CR}}\right) + 4.76 \end{aligned}$$

For colored lakes:

$$\begin{aligned} \mathrm{TSI} = {} & 0.848\left(\frac{1}{\mathrm{SD}}\right) + 0.809(\mathrm{COND}) + 0.887(\mathrm{TON}) \\ & + 0.768(\mathrm{TP}) + 0.930(\mathrm{PP}) + 0.780(\mathrm{CHA}) \\ & + 0.893\left(\frac{1}{\mathrm{CR}}\right) + 9.33 \end{aligned}$$

In these equations, the independent variables are standardized (i.e., raw value minus the mean for that parameter and the difference is divided by the standard deviation). The indicator parameters selected were:

SD = Secchi disk transparency in meters
COND = specific conductance in micromhos/cm
TON = total organic nitrogen in mg-N/l
TP = total phosphorus in mg-P/l
PP = primary productivity in mg-C/m^3/hr
CHA = chlorophyll-*a* in mg/m^3
CR = Pearson's cation ratio

Fifty-five lakes were sampled at 4-month intervals for one year and average values were used as raw input for each of the seven indicator parameters. The data were reduced to standardized values and the method of principal component analysis was used to generate the expressions for computing TSI values. Importantly, the coefficients

Table 2. FIFTY-FIVE FLORIDA LAKES RANKED ACCORDING TO TROPHIC STATE INDEX (TSI)

Lake	TSI
Hypereutrophic group	
Apopka	22.1
Twenty	18.5
Dora	18.5
Bivin's Arm	14.7
Griffin	13.7
Kanapaha	13.5
Alice	10.7
Eustis	10.5
Eutrophic group	
Hawthorne	9.1
Clear	8.8
Burnt Pond	8.3
Wauberg	7.4
Newnan's	7.1
Mesotrophic group	
Twenty-five	6.4
Harris	6.3
Twenty-seven	5.8
Cooter Pond	5.3
Lochloosa	5.2
Tuscawilla	4.8
Calf Pond	4.6
Orange	4.3
Mize	4.2
Watermelon Pond	3.6
Little Orange	3.4
Weir	3.3
Elizabeth	3.2
Ten	3.2
Palatka Pond	3.2
Beville's Pond	3.1
Meta	3.1
Oligotrophic group	
Jeggord	2.8
Moss Lee	2.8
Long Pond	2.8
Clearwater	2.6
Altho	2.5
Hickory Pond	2.5
Santa Fe	2.5
Suggs	2.3
Little Santa Fe	2.3
Adaho	2.2
Wall	2.1
Winnott	2.0
Ultraoligotrophic group	
Still Pond	1.9
Kingsley	1.9
Geneva	1.8
Gallilee	1.6
Swan	1.5
Anderson-Cue	1.5
McCloud	1.5
Brooklyn	1.5
Cowpen	1.5
Long	1.3
Sumter-Lowry	1.3
Magnolia	1.3
Santa Rosa	1.3

from Shannon & Brezonik (1972)

(weighting factors) in the TSI equations were not determined separately or arbitrarily, but were developed from correlative relationships among the indicator parameters. Thus, the approach is an attempt to deal directly with the multidimensional nature of trophic status. The constants which appear in each of the TSI equations were introduced to eliminate negative TSI values when zero raw data values are used; if all indicator parameters are zero, the TSI value is zero.

The system was judged to work very well for clear lakes; less well, but satisfactorily, for colored lakes. The composite ranking of the 55 lakes was divided into five groups as follows:

hypereutrophic -	TSI greater than 10
eutrophic -	TSI between 7 & 10
mesotrophic -	TSI between 3 & 7
oligotrophic -	TSI between 2 & 3
ultraoligotrophic -	TSI less than 2

The authors cite the major value of the TSI concept to be the possibility of ranking lakes in a logical and objective manner. They warn, however, that if the sample set is too diverse, interpretation of results may be difficult or impossible, and they did not suggest extending the TSI concept to develop a single, universal index for all lakes.

A classification system based on a straight-forward ranking approach is reported by Lueschow *et al* (1970). In this study, 12 relatively well-known lakes in Wisconsin were selected for analysis. Care was taken in selecting the lakes to assure that the set contained a variety of types ranging from oligotrophic to eutrophic. Seven parameters were selected for measurement: 1) hypolimnetic dissolved oxygen, 2) plankton (No. 20 mesh net), 3) Secchi disk transparency, 4) organic nitrogen, 5) total inorganic nitrogen, 6) soluble phosphorus, and 7) total phosphorus; and the study was then conducted to determine whether or not these parameters would permit the test lakes to be ranked in a manner consistent with their perceived trophic condition.

The lakes were sampled at monthly intervals for one year, and average values of each parameter, except dissolved oxygen, were used for classification purposes. Minimum dissolved oxygen concentrations, measured 1 meter off the bottom, were used.

Classification was accomplished by selecting one parameter and then ranking all 12 lakes according to that parameter alone. This was done for each of the seven parameters listed above. Difficulty was encountered with the total and soluble phosphorus data, however. Four of the 12 lakes had received treatments with arsenic compounds for aquatic nuisance control in the past. Consequently, arsenic interference with the phosphorus determinations precluded use of the data for these lakes; therefore, only eight of the lakes could be ranked with respect to the two phosphorus parameters.

A composite ranking of the 12 lakes was then prepared from five of the individual rankings; phosphorus rankings were ignored for the composite. Points were assigned to each lake equivalent to its position in the rankings, i.e., one point for first, two for second, and so forth. Points were then totalled for the five lists. Possible scores ranged from 5 to 60 with eutrophic lakes scoring highest.

Scores for the 12 lakes tested ranged from 8 to 52 as shown below. Although consideration of phosphorus concentrations was not entered into the composite rankings, the authors state that including phosphorus would not alter the results significantly. The final ranking produced by Lueschow *et al* is generally regarded as a realistic one by limnologists familiar with the 12 test lakes.

Table 3. COMPOSITE RATING OF 12 WISCONSIN LAKES

	Rank	Lake name	County	Composite score
Most oligotrophic ↑	1	Crystal	Vilas	8
	2	Big Green	Green Lake	17
	3	Geneva	Walworth	17
	4	Trout	Vilas	19
	5	Round	Waupaca	31
	6	Pine	Waukesha	33
	7	Middle	Walworth	33
	8	Oconomowoc	Waukesha	34
Most eutrophic ↓	9	Mendota	Dane	45
	10	Pewaukee	Waukesha	49
	11	Delavan	Walworth	52
	12	Winnebago	Winnebago	52

from Lueschow *et al* (1970)

A modification of the methodology presented by Lueschow *et al* was used to classify 209 lakes and reservoirs as part of the preliminary data analysis for the National Eutrophication Survey (U.S. Environmental Protection Agency, 1974). The basic approach is the same, but some changes were made in the input parameters, and the absolute ranking technique used by Lueschow *et al* was replaced with a percentile ranking procedure.

The six parameters selected for inclusion in the classification were: 1) total phosphorus, 2) dissolved phosphorus, 3) inorganic nitrogen, 4) Secchi depth, 5) minimum dissolved oxygen (in hypolimnion if stratified), and 6) chlorophyll-*a*. It is suggested that input values be means or medians for the entire lake, but no information is given regarding the time of sampling or if averages of several sampling dates should be used.

To classify lakes, percentile rankings are determined individually for each of the six parameters (The values for Secchi disk transparency and minimum DO were first subtracted from fixed values, so that all parameters indicative of decreasing water quality affect percentile rankings in the same direction.), and composite values are determined by summing each of the six percentile ranks. Composite ranking values were termed, "Trophic Index Numbers," (TIN). Since a percentile ranking system was used, the range of possible TIN values depends on the number of lakes classified; however, if 99 or more lakes are classified, the possible range extends from 0 to 594 (6x99).

Results of the classification of more than 200 lakes in the northeast and north-central parts of the country were judged to be quite satisfactory. Some difficulties were encountered with reservoirs having short hydraulic-residence-times and with shallow lakes having extensive macrophyte growths, but the problems were minor. For the data set analyzed, the following lake type-TIN ranges were found to apply:

0-420	eutrophic
420-499	mesotrophic
500-594	oligotrophic

It should be noted, however, that these ranges are meaningful only for the specific data set analyzed, because TIN values (or index values from any relative classification system) are indicative of a lake's rank relative to others in the data set, but have no absolute meaning. Therefore, TIN values cannot be used directly to compare two sets of lakes classified separately by the same system.

Statistically significant differences were used as a basis for lake classification by McColl (1972). Surface and bottom waters of 7 New Zealand lakes were sampled monthly for one year, and 24 different chemical determinations were made. Chemical analyses included dissolved oxygen, major ions, silica, P, N, algal pigments and some trace elements.

It was found that dissolved oxygen (hypolimnetic deficiencies), Secchi disk transparency, alkalinity differential between epilimnion and hypolimnion in summer, algal pigment, P, N, Fe, and Mn were related to trophic status. On the contrary, no relationship was found between trophic status and pH, Ca, Mg, Na, K, SO_4, Cl, Cu, Zn, Si and total dissolved solids. These parameters were then set aside, and analyses of variance, t-tests, and Tukey's Studentized range tests were used to classify the 7 lakes based on the remaining parameters. Groups were formed by determining whether means of given parameters diffused significantly at the 1% level (P=0.01).

The statistical procedures resulted in the separation of the 7 lakes into three subsets--two lakes were judged to be eutrophic, two were mesotrophic and three were oligotrophic. The results were judged to be a realistic classification.

In France, Feuillade (1972) used factor analysis to compare data from two lakes and reported that the technique may be useful for lake classification on a much broader scale.

A thorough discussion of the philosophy, as well as the techniques, of classification is reported by Sheldon (1972). After a comprehensive discussion of statistical methods, he employs a combination of principal components reduction, vector ordination, and the D measure of the Gower method (Gower, 1966) to the physical, chemical, and biological data collected from different regions of the world by various investigators. Sets of lakes studied by others are reclassified by Sheldon, but the rankings are de-emphasized in favor of the general methodology. The author's main purpose is to demonstrate that statistical procedures can be used to delineate the same grouping of lakes determined by other workers, but in a more orderly and universal fashion. As examples, Sheldon ranked 121 lakes in North America and 15 in Sweden and showed that numerical analysis can be used to form groups of lakes that are limnologically similar, without resorting to empirical classification systems designed to incorporate some aspects of the eutrophication process. Other advan-

Table 4. CLASSIFICATION OF 7 NEW ZEALAND LAKES

Lake	Parameter			
	Mean (geometric) surface water		Maximal summer surface water (Dec., Jan., Feb.)	
	Chlorophyll	Total P	Reactive PO_4-P	Nitrate-N
	µg/1			
Eutrophic				
Okaro	17	69	11	8
Ngapouri	8	50	17	3
Mesotrophic				
Rotokakahi	3	25	5	2
Okareka	2	13	5	3
Oligotrophic				
Okataina	1.2	14	5	3
Rotoma	1.7	9	5	2
Tikitapu	1.3	5	4	1

after McColl (1972)

tages of this general approach are 1) the rapid retrieval of information, 2) the ability to organize large data sets, and 3) the ready identification of unusual or unique qualities.

Sheldon's philosophical commentary is at least as valuable as his contribution to method. In a lucid discussion of classification in general, he asserts that the resource planning process neglects the small lakes in favor of the "large, spectacular, and unusual" which will be managed, abused or preserved quite independently of the rest. While citing the value of simple, one-directional classification systems, Sheldon warns against the use of classification systems as a substitute for knowledge, and suggests that special use or single purpose classification systems breed conflict rather than resolve it.

Systems to classify lakes according to trophic status are summarized in Table 5. This summary illustrates some of the difficulties related to developing these systems. There presently exists no generally-accepted definition of the term, "trophic status." This is pointed out quite clearly by the different parameters which were selected as indicators, and the different ways in which these parameters were combined in the various systems. The number of input parameters ranged from 4 to 16 and, in some cases, single measurements were sufficient while repetitive determinations were required in others.

Lack of a precise definition of "trophic status" also makes it difficult to assess the "accuracy" of different systems. When developing analytical procedures in chemistry, one can prepare a set of standard solutions to test the procedure. No analogous set of standards exists for measuring trophic status of lakes. At best, one can evaluate the results on a subjective basis to see if they appear to be reasonable. All of the techniques used were judged by the investigators to yield reasonable results. In most cases it was felt that the technique might have broader application, and it was suggested that the systems be applied with caution elsewhere.

The techniques reported by EPA (1974), Feuillade (1972), Lueschow *et al* (1970), McColl (1972) and Sheldon (1972) are all relative systems in which lakes are classified only with respect to each other and not to some independent scale. (To some extent, the system described by Shannon and Brezonik (1972) is also the relative type because the coefficients in the TSI equations are determined from the input data set.) This is considered to be a disadvantage for most

Table 5. SUMMARY OF SYSTEMS TO CLASSIFY LAKES ACCORDING TO TROPHIC STATUS

Investigators	Lakes classified	Group	Rank	Pre-set	Post-set	Independent	Relative	Analytic	Empirical	Parameters used
EPA	209		X		X		X		X	DO, tot-P, sol-P, inorg-N, Secchi, chlor-*a*
Feuillade	2-France	X			X		X	X		Temp, DO, cond, NH_3-N, NO_3-N, NO_2-N, Ca, Mg, Cl, SO_4, Si, sol-P, K, Na, hardness, alk
Lueschow *et al*	12-Wisconsin		X		X		X		X	DO, plankton wt, Secchi, org-N, inorg-N (avg monthly values)
McColl	7-N.Zealand	X			X		X	X		DO, Secchi, alk, chlor-*a*, pigment, tot-P, sol-P, NO_3-N, NH_3-N
Newton and Fetterolf	10-Michigan		X		X	X			X	Sol-P, COD, org-N, NH_3-N
Shannon and Brezonik	55-Florida		X		X	X		X		Secchi, cond, org-N, tot-P, prim. prod., chlor-*a*, Ca, Mg, Na, K (avg of 3-6 seasonal values)
Sheldon	121-N.America	X			X		X	X		pH, trans, alk, temp, depth, DO
Sheldon	15-Sweden	X			X		X	X		pH, trans, color, $KMnO_4$ demand, cond
Zafar	-	X		X		X			X	N, P, Ca, K, Na, Mg, humus

broad-scale applications because the classification of specific lakes may change if additional lakes are added to the data set and index numbers have meaning only with respect to the lakes in that set. However, it is likely that most of the systems could be modified to eliminate or minimize the disadvantage.

From a practical standpoint, it is interesting to note that data collection was an integral part of the classification studies except for the work of Zafar (1959) and Sheldon (1972). The other investigators found that sufficient data were not available from other sources, even though 12 or fewer lakes were classified in four of the reported studies. Lack of uniform data imposes a serious constraint on the immediate, broad-scale use of any of the systems listed in Table 5.

SECTION IV

DATA ACQUISITION

With the data requirements for the various lake classification systems in mind, an assessment was made of the number of lakes throughout the country which could potentially be classified using one of the published techniques. Toward this end, an attempt was made to determine whether sufficient data had been compiled by various state agencies, and whether this data might be made available for the purpose of lake classification. Contacts were made with conservation departments, fish and game commissions, pollution control agencies or natural resources departments in each of the 50 states to determine: 1) the number of lakes in each state, 2) the number of lakes larger than 100 surface acres (40 ha), and 3) the extent to which water quality data had been compiled for the lakes. (The selection of 100 acres as a breakpoint was an arbitrary decision intended to form a smaller, more workable subset for the initial analysis, and to concentrate on the larger lakes which were judged most likely to be of regional, rather than local, significance.)

Results of our inquiries are summarized in Tables 6 and 7. It was found that complete lake inventories have been conducted in 34 of the 48 contiguous states; however, for 9 of these the data are unpublished (and may be located in scattered office files without a summary compilation available). By a complete inventory it is meant that lakes are identified by name, location, size and sometimes depth, and that the inventory covers the entire state and includes all lakes with surface areas larger than 50 acres. An additional 7 states have conducted partial inventories. Major reservoirs only have been listed for Alabama, Kansas, Texas and Virginia; a registry of dams is available for California and North Carolina. Nebraska has conducted an inventory which covers only the sandhills area of the state, but includes most of the state's lakes.

Table 6. SUMMARY OF LAKE INVENTORY DATA

State	Status of lake inventory	Number of lakes inventoried	Minimum size in acres	Number of lakes larger than 100 acres
Alabama*	c	35	500	35
Arizona	a	451	-	90
Arkansas	a	2,334	5	361
California*	c	1,050		311
Colorado*	d	(763)		(163)
Connecticut	a	493	5	121
Delaware*	b	55	-	(20)
Florida	a	7,712	10	916
Georgia*	d	(45)		(15)
Idaho	b	2,178	-	83
Illinois*	a	2,167	6	192
Indiana	a	547	-	131
Iowa	a	311	-	85
Kansas*	c	141		(47)
Kentucky*	a	285	10	(21)
Louisiana*	d	(713)		(262)
Maine*	b	3,094	-	(454)
Maryland*	d	(47)		(6)
Massachusetts	a	1,557	10	294
Michigan*	b	7,661	5	1,070
Minnesota	a	15,291	10	4,012
Mississippi*	d	(216)		(74)
Missouri*	b	(1,254)		(98)
Montana*	d	(1,712)		(308)

* = Additional commentary given in appendix
( ) = Estimated values (probably minimum)
- = No minimum size specified

Status of lake inventory:
a = Complete inventory, published
b = Complete inventory, unpublished
c = Partial inventory
d = No inventory

Table 6. SUMMARY OF LAKE INVENTORY Con't

State	Status of lake inventory	Number of lakes inventoried	Minimum size in acres	Number of lakes larger than 100 acres
Nebraska*	c	1,885		(193)
Nevada	a	329	-	52
New Hampshire	a	845	-	183
New Jersey	a	1,727	-	89
New Mexico	a	200	-	32
New York	a	4,155	6.4	654
North Carolina*	c	928		(48)
North Dakota*	d	(2,562)		(265)
Ohio	b	3,017	2	127
Oklahoma	a	1,777	10	113
Oregon*	b	6,435	1	190
Pennsylvania*	a	2,403	-	200
Rhode Island	a	175	-	46
South Carolina	a	193	50	86
South Dakota	a	488	-	231
Tennessee	a	552	5	65
Texas*	c	152		152
Utah	a	256	-	24
Vermont	a	535	-	98
Virginia*	c	435		(21)
Washington	a	7,894	1	300
West Virginia*	b	(8)		(7)
Wisconsin*	a	5,553		1,147
Wyoming*	b	2,261	-	(107)
Totals		94,877		13,599

* = Additional commentary given in appendix
( ) = Estimated values (probably minimum)
- = No minimum size specified
Status of lake inventory:
a = Complete inventory, published
b = Complete inventory, unpublished
c = Partial inventory
d = No inventory

Table 7. AVAILABILITY OF WATER QUALITY DATA FOR LAKES[†]

State	Physical data	Major chemical constituents	Minor chemical constituents	Biological analyses
Alabama	28	3	2	
Alaska	12	7	2	4
Arizona	11	5	-	3
Arkansas	63	4	1	3
California	75	18	4	7
Colorado	64	23	1	11
Connecticut	26	6	1	2
Delaware	-	-	-	-
Florida	208	163	?	?
Georgia	16	2	-	-
Hawaii	1	1	1	-
Idaho	27	12	4	-
Illinois	127	11+	-	-
Indiana*	*	*	*	*
Iowa	16	?	-	-
Kansas	77	23	-	19
Kentucky	76	54	-	?
Louisiana	9	?	-	-
Maine*	*	*	*	*
Maryland	8	-	-	-
Massachusetts	16	-	-	-
Michigan	89+	37	4	11
Minnesota*	*	*	*	*
Mississippi	25	6	-	?
Missouri	8	-	-	-
Montana	74	18	2	-

[†] This tabulation does not include the EPA National Lake Survey data.

*Sizable monitoring programs, but summary information not available.

Table 7. AVAILABILITY OF WATER QUALITY DATA FOR LAKES[†] Con't

State	Physical data	Major chemical constituents	Minor chemical constituents	Biological analyses
Nebraska				
Nevada	50	?	-	-
New Hampshire*	*	*	*	*
New Jersey*	*	*	*	*
New Mexico	4	?	-	-
New York*	65+*	65+*	-*	?*
North Carolina	71	13	3	7
North Dakota	189+	34+	-	?
Ohio	82+	?	-	12
Oklahoma	42	-	-	-
Oregon*	*	*	*	*
Pennsylvania*	*	*	*	*
Rhode Island*	*	*		
South Carolina	149	32	8	18
South Dakota	38+	?	-	-
Tennessee	145+	?	-	-
Texas	24	4	-	-
Utah	21	-	-	-
Vermont	42	?	-	-
Virginia	15+	?	-	-
Washington	37+	25+	?	?
West Virginia	47	8	2	-
Wisconsin*	400+	400+		
Wyoming	34	12	-	-

[†] This tabulation does not include the EPA National Lake Survey data.

*Sizable monitoring programs, but summary information not available.

When lake inventory information was not available, an attempt was made to estimate the number of lakes. In some cases, estimates were provided by agency representatives (Del, Ga, Kans, Ky, Me, Neb, N.C., Va, W.Va); and for eight states, project personnel counted lakes which appear on 1:500,000 scale maps obtained from the U.S. Geological Survey (Colo, La, Md, Miss, Mo, Mont, N.D., Wyo). Tabulations from maps should be interpreted as minimum values because small lakes (<40-50 acres) were not shown. Lake sizes were estimated from the maps to determine the number of lakes with surface areas larger than 100 acres.

It was found that at the time of this survey there were 11,490 lakes larger than 100 acres listed in inventory records. It is estimated that there are an additional 2,109 of these lakes, making a total of 13,599 "large" lakes. This is considered to be a good estimate which is not likely to be in error by more than a few percent.

A total of 94,877 lakes are listed in Table 6 (87,557 from inventories; 7,320 from maps). Although these numbers represent the best data obtained in the survey, it is known that these estimates are far less accurate than those given for larger lakes. There are several reasons for this, but probably the most important factor is the lack of a universal definition of what constitutes a lake. The approach used in compiling most state inventories was to specify a minimum surface area which must be exceeded for a water body to be included in the lake inventory. Values between 5 and 10 acres were used most often for the minimum size criterion.

Selection of minimum lake sizes drastically affects the number of lakes that "exist" in any state. For example, the lake inventory in Illinois lists 2,167 lakes which are 6 acres or larger (Lopinot, 1966). The same report states that in 1965 there were 62,627 ponds in Illinois (mostly impoundments) ranging in size from 0.1 to 5.9 acres, and that an average of 1,590 impoundments were constructed each year between 1963-65. Thus, lakes larger than 6 acres accounted for only 3.3% of the total number of "lakes" but, at the same time, 79.6% of the total surface acreage came from the larger lakes.

This example illustrates the degree of variability in total lake numbers which can be introduced by different minimum size criteria. The numbers given in Table 6 have not been adjusted to any standard definition of "lake," and this should be taken into account when conclusions are drawn from the data. In preparing the table, no distinction was made between natural lakes and reservoirs; both types are included. However, farm ponds are not included, and intermittent lakes were excluded wherever possible.

Hawaii and Alaska are not included in the lake summary. Hawaii has 9 lakes--5 larger than 100 acres. The total number of lakes in Alaska is not known; however, there are 94 lakes with surface areas in excess of 10 square miles, and the total number may be greater than the combined total in the remaining states.

An attempt was also made to determine the availability of water quality data for lakes throughout the country--particularly for the larger lakes. It was hoped that an estimate could be made of the number of lakes which could be classified using each of the systems described in the preceding section. This effort was only partially successful. It was not possible to obtain descriptions of existing data holdings in sufficient detail to quantify the degree to which each of the various systems could be used; however, a general description of the information received through our inquiry is summarized in Table 7. The number of lake monitoring stations are listed by state and the type of data collected is separated into four general categories:

1) field measurements and physical data - to include one or more of the following: temperature, transparency, specific conductance, dissolved oxygen, pH;
2) major chemical constituents - to include one or more of the following: P, N (the various species), Cl, SO_4, Fe, Ca, Mg;
3) minor chemical constituents - such as trace metals and miscellaneous organic compounds;
4) biological measurements - to include zooplankton and phytoplankton measurements, bacterial analyses and/or rooted aquatic plant surveys.

Generally, the figures may be described as sketchy at best. The numbers listed are almost certainly underestimates (the research literature of the past five to ten years suggests more lake monitoring stations than are accounted for in Table 7). Through the course of our inquiry it was noted, ironically enough, that the ability to assess a state's program varied inversely with the size of the program. That is, those states with the most comprehensive monitoring efforts were the least able to quantify the extent or character of those efforts. Nine of the states listed in Table 7 (those marked with an asterisk) are known to have sizable water quality monitoring programs, but no accurate summary information was available. For this reason no totals have been calculated for the various data categories.

Qualitatively, the figures may imply more data than actually exist because many of the stations have been monitored only once, and then for only one or two parameters. Very few of the stations have been sampled on a regular basis (i.e., monthly or quarterly) or for detailed, comprehensive analyses. Furthermore, the range and variability of available lake data within a state are often great. As an example, the state of Wisconsin has two to three dozen lakes which have been the subjects of fairly intensive investigation by educational institutions and state agencies. The state's Department of Natural Resources (DNR) is currently monitoring approximately 200 lakes on a quarterly basis for a wide spectrum of limnological parameters. Similar data are available for an additional 100 lakes which are not currently monitored. The DNR "Surface Water Inventory Program" has been in existence for over 15 years, and during its course virtually all of Wisconsin's lakes have been surveyed at least once, although some of this information is no longer current. Finally, at the bottom of the scale there will be a few lakes about which little or nothing is known.

While the results of this portion of our inquiry have proved inadequate for determining the number of lakes which could be classified with the systems described previously, the reasons for these vagaries are worth enumerating for their own sake.

1) Some states have no formal monitoring program at all and the data which exist have been generated through university research programs or contracts with federal agencies. To the extent that such information was available from state officials it is included in Table 7, but our survey was limited to state agencies--no inquiries were made directly to educational institutions or federal agencies.

2) Other states have monitoring programs, but these are often limited to a small number of sites for special purposes. A number of states have programs which emphasize river and stream surveys for water supply (quantity rather than quality), flood control, or public health purposes.

3) Still other states have programs for which several agencies (including county and municipal as well as state) share responsibility, but not necessarily mutual interest or goals. Consequently, the information available to any given agency may be limited to the results of its own efforts.

4) Finally, a few states do have monitoring programs of significant size, but in such cases there is no "summary" information available and it appeared that data handling and exchange were noteworthy problems.

At this point, distinction should be made between the existence and accessibility of data. In most states, the responsibility for gathering lake data is split among several agencies, and interagency coordination is sometimes weak. Shared data banks are not common, and data exchange between agencies is often cumbersome. Problems of accessibility are further compounded by the lack of centralized data storage within many agencies. A common response to our inquiries was, "I believe the type of data you are seeking has been collected for some of our lakes, but the data would be located in the files of our district offices and it would be a major undertaking for this information to be pulled together." Concern was also expressed for the quality, completeness and comparability of existing data, but fragmentation of data holdings was clearly the factor which most seriously limits data accessibility. This is not to imply that the need for data consolidation was not recognized; on the contrary, the need was widely recognized, but practical constraints of staff limitations and fiscal problems have hampered progress in this direction. However, several states reported that coordinated data collection and storage programs are in the planning stage, and expressed optimism that recent and future legislation would encourage an expanded, coordinated approach with well-defined long-term goals.

Efforts to assess the present lake data base led to the following conclusions:

1) The number of lakes for which water quality data exist is small, and the number for which it is accessible is even smaller. Even when only those lakes larger than 100 acres are considered, data sufficient to utilize reported lake classification systems are not available for the vast majority of lakes. For smaller lakes, the situation is even more bleak.

2) Consolidation of existing data within states would permit the classification of more lakes, but the total number would still be small. Accessibility of this data to parties in other states is virtually impossible.

Thus, it became obvious quite early in the study that if classification of any significant number of lakes was to be accomplished, a system requiring very minimal data input would have to be devised; insofar as possible, subjective information would have to be used as a replacement for field data; and compilation of even this minimal information would have to be undertaken as an integral part of the classification effort. The necessity of compiling an information base also led to consideration of perhaps collecting auxiliary information which would facilitate the use of lake classification in a management context. It was felt that, if possible, the information collected should not only be indicative of the trophic character of lakes, but should also contribute to the development of management strategies for lake renewal and protection.

It was concluded that a far better perspective of the options and priorities for broad-scale lake management would be attained if it were possible to identify three general lake-quality categories:

1) those lakes which are presently of high quality and are not expected to degrade in the near future;
2) those lakes which are of high quality, but are subject to degradation and require protective action to maintain their present condition; and
3) those lakes which have deteriorated to the extent that protective action is no longer sufficient and rehabilitation is necessary to restore satisfactory water quality conditions.

Each of these categories implies a combined knowledge of lake condition and nutrient loading rates. The ideal approach of obtaining specific loading rates for nitrogen and phosphorus, and lake residence-time data for conservative and nonconservative substances was not a realistic option for a project of this scope. However, it did appear feasible to collect general land-use information for lake basins so that nutrient loading rates could be approximated.

Another consideration, which was significant in shaping the basic approach used, had to do with the use of fragmentary field data as a basis for classification. In particular, questions arose regarding the use of nutrient data when only a single measurement was available for a lake. Is a single measurement of dissolved inorganic phosphorus a meaningful indicator of the trophic character of a lake? It was decided that the use of numerical data of this type would probably contribute little useful information, and considering the time and space variations of many chemical parameters (without regard to differing sampling and analytical techniques), it was judged that reliance on single-point values could easily lead to misleading or erroneous results. This is not to say that fragmentary data should be totally ignored, but its use should be tempered by judgment. The values should not be used blindly by entering them into an equation for calculating a "trophic score."

In accordance with the above information and philosophy, an approach was developed in which lake information would be sought from individuals who had personal knowledge of the lakes in question, were familiar with basic limnological principles, and had access to whatever data might exist. Thus, a standard data form, or "questionnaire," was designed with the intent that responses would be solicited from resource managers or individuals in similar positions who could provide the firsthand information we requested.

The data form finally selected (see appendix) was the product of an iterative process which involved several generations in its development. Initially, a small group of researchers put together a "questionnaire" for use in obtaining the desired information. Emphasis was directed not only to "what is needed," but equally, or perhaps even more strongly, to "what can we eliminate and still have valid results." Draft forms underwent peer review and were also submitted to several individuals who were representative of the type of respondents likely to be asked later to provide information. The latter group was asked to give an assessment of the extent to which requested information could be provided and to identify items which would be difficult (or impossible) to provide. The development also involved computer specialists to minimize potential difficulties in data processing and handling. Fortunately, it was practical to design the input form primarily for ease and continuity of thought for those who would be providing the selected information--it was not necessary to impose a computer format on the data form itself. This was viewed as a distinct advantage by those asked to complete data forms.

The input form selected does not completely ignore "data" or hard numbers, but nearly so. Numbers are requested for certain descriptors, such as area, depth, and location. And, regarding shoreline development and drainage area land use, "percentage" estimates are requested; but the remaining questions are answered "yes" or "no," or by checking the appropriate range or category. Basically, the questions are in the following categories:

1) physical and morphometric characteristics;
2) water quality (dissolved oxygen, transparency, etc.);

3) problems, impairment, and treatments;
4) availability of background information;
5) drainage area land use; and
6) potential sources of pollutants or nutrients.

It must be emphasized that the design of this data form to "ignore data" is not intended to demean the value of detailed studies which must ultimately be performed in any serious attempt at lake renewal and management. Rather, the purpose here is to gather a significant amount of scientifically valid information which is realistically acquired and computer compatible. With regard to the latter, arrangements were made with the University of Wisconsin Data and Computation Center for data processing and storage of information generated by the inventory. A program was written which transfers coded data punched directly from the questionnaire to a data file on magnetic tape.

The questionnaire was designed for use throughout the country, but a decision was reached to concentrate initial efforts in Wisconsin to: 1) test the questionnaire, 2) gain preliminary insight into the results, and 3) explore the administrative arrangements necessary to procure information. (One factor which contributed to this decision was the passage of the 1972 Amendments to the Water Quality Act which included the provision that ". . . . .each State shall classify its publicly owned lakes according to eutrophic conditions." Thus, the responsibility for classifying lakes was placed squarely on each state, and similar efforts by outside groups were, in some instances, viewed as a duplication of effort.)

In Wisconsin, the primary responsibility for lake management is vested with the Department of Natural Resources, and arrangements were made with that agency to provide the necessary lake information for the state. Some of the desired information had already been compiled by the DNR and was stored in a computer data file. A study of the file contents showed that 23 items--about 30% of the needed information--were contained in the data file. A print-out of this information was provided by the DNR and was transferred to the data forms by project personnel.

At this point it was possible to define precisely the additional information that was required to complete the forms, and a meeting was held with administrative representatives of DNR to explore the possibility that district personnel could provide the needed data. The representatives were extremely hesitant to commit the necessary manpower to this effort because their staffs were already overtaxed and would not have time to take on the added task. However, an agreement was reached with the approval of the granting agency whereby the DNR would be compensated for the time spent by its personnel in providing the lake data.

Because the cost of obtaining data is an important factor in any effort, the project's expenditures are outlined below:

District	Number of lakes	Total cost	Cost per questionnaire
Southern	44	($112.00)	$2.55
West Central	46	(288.75)	6.28
Northwestern	422	(1113.00)	2.64
North Central	512	(560.00)	1.09
Lake Michigan	60	*	-
Southeastern	65	*	-
	1149	($2073.75)	$2.02

The total cost for the 1024 lake forms completed by the DNR was $2,073.75, or an average of $2.02 per questionnaire. However, the cost per questionnaire varied substantially among districts, a factor to be considered in any large-scale or nationwide effort. If the North Central District, with 512 lakes, had furnished the information at the same unit cost as the West Central, the total cost for the former would have been $3221 rather than $560. The North Central District, with the lowest unit cost, nevertheless furnished the most complete data forms and the highest quality information.

It should be noted that the majority of the lake data for Wisconsin was provided by a relatively small number of people. Only about a dozen individuals were involved directly in completing the data forms, although they did contact additional people for specific items. This provided a degree of uniformity to the data base--an important factor when subjective judgments are involved--and also permitted project personnel to meet with each respondee to explain project objectives and answer questions. This latter aspect was significant in expediting compilation of the information base. It is doubtful that the data base could have been developed if the questionnaires were mailed to a large number of potential respondents.

In spite of the care exercised in specifying the information to be collected, the arrangements which were made to procure the data, and follow-up efforts by project staff, it was not possible to obtain all the requested information for all lakes. The most troublesome items were related to the direct drainage areas for lakes and land use characteristics within these drainage basins. Drainage areas have not been delineated for all lakes--topographic quadrangles have not been prepared for some portions of Wisconsin, and information regarding land use within drainage basins is only approximate. However, those items necessary for characterizing the trophic nature of lakes were obtained for virtually all lakes in the survey.

SECTION V

TROPHIC CHARACTERIZATION OF WISCONSIN LAKES

Because of constraints imposed by the lack of chemical and biological data for most lakes, a classification system was developed which is based on some of the more readily observable indicators of eutrophication. A technique was devised in which "penalty points" were assigned to lakes depending upon the degree to which they exhibited undesirable symptoms of water quality. Four parameters were selected for analysis, and ranges of values for each parameter were specified which depicted lake conditions ranging from desirable to undesirable. The parameters used and the range of possible points assigned are listed below.

Table 8. POINT SYSTEM FOR LAKE CONDITION INDEX

Parameter	Points
Dissolved oxygen	0-6
Transparency	0-4
Fishkills	0,4
Use impairment	0-9
Total	0-23

The parameters were treated independently, and composite lake ratings were determined by summing the number of points assigned in each of the four categories. The sum is termed a "Lake Condition Index" (LCI).

It is important to recognize that although the system is designed to segregate lakes according to the extent to which they display undesirable characteristics normally associated with eutrophication, the LCI is not necessarily synonymous with "trophic status" or "productivity." Two equally productive lakes could have different LCI values, depending on the manner in which this productivity influences the oxygen regimen, transparency, fish survival and recreational uses of the lake. For example, two lakes of varying depth may be very similar in productivity. The deeper lake, with its larger hypolimnetic volume forestalling oxygen depletion, would receive few penalty points for this condition and, as a result, have a low LCI. On the other hand, hypolimnetic oxygen depletion would likely be a common occurrence in the shallower lake, and its LCI could be substantially higher due to the penalty points it received as a consequence.

Dissolved oxygen in the hypolimnion was selected as one parameter for consideration because depletion of hypolimnetic oxygen supplies reflects the integral effect of many lake processes. The rate of hypolimnetic oxygen depletion, normalized to account for lake morphometry, would likely be an excellent parameter for classifying lakes. However, even though DO profiles are one of the more common measurements made on lakes, the frequency of measurement is often insufficient to permit calculation of depletion rates. Therefore, as a compromise, the classification methodology for DO was based on the minimum conditions which were expected to occur in the hypolimnion during the stratified period. Points were assigned in the following manner:

	Penalty points	
Dissolved oxygen conditions	Max depth <30'	Max depth >30'
Dissolved oxygen in hypolimnion greater than 5 ppm at virtually all times	0	0
Concentrations in hypolimnion less than 5 ppm but greater than 0 ppm	1	2
Portions of hypolimnion void of oxygen at times	3	4
Entire hypolimnion void of oxygen at times	5	6

As noted in the tabulation above, lake morphometry was taken into account in an approximate way by assigning more points to the deeper lakes. The breakpoint of 30 ft (10 m) maximum depth was selected arbitrarily as an indicator of lake basin geometry, which separates lakes with "large" or "small" hypolimnetic volumes as compared to the volume of the epilimnion.

Lakes which do not stratify can receive few or no penalty points for dissolved oxygen conditions. This affects the LCI values of reservoirs with short hydraulic retention times as well as shallow lakes which undergo continual overturn.

Secchi disk transparency was incorporated into the system by using typical annual maximum and minimum Secchi depths. Ranges rather than specific values were used.

Range	Typical Secchi depth
1)	0 - 1.5 ft (0 - 0.5 m)
2)	1.5 - 10 ft (0.5 - 3 m)
3)	10 - 23 ft (3 - 7 m)
4)	>23 ft (>7 m)

The first range represents a condition in which light penetration would be severely limited. Within the second range, the depth of the photic zone is likely to be less than the depth of the epilimnion. Conversely, Secchi depths within the third range are indicative of a photic zone which extends below the epilimnion except for large lakes.

Points were assigned according to the combination of depth ranges which encompass the typical maximum and minimum Secchi depths. In the tabulation below, the above-listed range numbers of 1-4 are used: (Note: A provision is also included to cover the possibility that only one range of Secchi depths would be given.)

Transparency conditions if both ranges are given

Minimum range	Maximum range	Penalty points
1	1	4
1	2	3
1	3	2
1	4	2
2	2	2
2	3	1
2	4	0
3	3	0
3	4	0

Transparency conditions if only one range is given

Secchi depth range	Penalty points
1	4
2	2
3	1
4	0

The occurrence of fishkills was considered in the classification system, but no attempt was made to stipulate frequency or severity. Lake depth was taken into account however, and 30 ft (10 m) was again used as the breakpoint.

History of fishkills	Penalty points
None	0
Yes, max depth <30'	3
Yes, max depth >30'	4

The presence of algal blooms and excessive rooted aquatic vegetation was approached indirectly through information describing the severity of recreational use impairment due to the overabundance of these aquatic plants.

Recreational use impairment

	Penalty points		
	Weeds only	Algae only	Weeds & algae
No impairment of use			
Very few algae present, no "bloom" conditions AND/OR Very few weeds in littoral zone	0	0	0
Slight impairment of use			
Occasional "blooms," primarily green species of algae AND/OR Moderate weed growth in the littoral zone	2	2	2
Periodic impairment of use			
Occasional "blooms," predominantly bluegreen species AND/OR Heavy weed growth in littoral zone	3	4	5
Severe impairment of use			
Heavy "blooms" and mats occur frequently, bluegreen species dominate AND/OR Excessive weed growth over entire littoral zone	6	7	9

Lakes were penalized least heavily for problems resulting from "weed" growths; lakes having both "weed" and algae problems were penalized most severely. This was based on the rationale that algal blooms often affect an entire lake whereas the effect of rooted aquatic vegetation is normally restricted to the periphery. Also, rooted vegetation is sometimes more indicative of lake morphometry than water quality conditions.

Lake Condition Indexes were calculated by summing the points received in each of the four categories. Thus, if a lake exhibits none of the specified undesirable symptoms of eutrophication, it would receive no points (LCI = 0). Conversely, for a lake to receive an LCI of 23 it would have to have all the undesirable characteristics in the most severe degree.

Initially, information regarding specific conductance and alkalinity was included in trial computations of LCI values, but these parameters were subsequently omitted when it was determined that they had very little, if any, effect on the results.

Prior to general use of the classification system for Wisconsin lakes, tests were conducted to determine the "reasonableness" of results generated by the technique.

One test involved the computation of LCI values for the same 12 lakes classified earlier by Lueschow *et al* (1970). Results of this comparison are given in Table 9. Both systems resulted in the formation of four subgroups of lakes. In addition, the general makeup of each of the subgroups was identical; however, there were some differences in the ordering of lakes within the subgroups. It was concluded that the LCI system worked very well in this test. The results presented by Lueschow *et al* were based on annual averages of monthly determinations of five parameters. Results equally as reasonable were achieved with much less input data using the LCI approach. This was encouraging because it would not be possible to rank many lakes if extensive data were required.

Another test was conducted by ranking subsets of lakes from four different areas of the state. Each subset consisted of approximately 40 lakes. The purpose of the test was to determine if the classification system would differentiate between lakes within a subset and, also, differentiate between the average conditions of lakes in the four subsets. In this case, less emphasis was placed on the classification of specific lakes because there was no quantified baseline

Table 9.
COMPARATIVE RANK OF 12 WISCONSIN LAKES

	Lueschow *et al*		Lake inventory	
	Score	Lake name	Lake name	LCI
Most eutrophic ← ↔ → Most oligotrophic	8	Crystal	Crystal	0
	17	Big Green	Trout	2
	17	Geneva	Big Green	4
	19	Trout	Geneva	5
	31	Round	Round	7
	33	Pine	Pine	7
	33	Middle	Middle	7
	34	Oconomowoc	Oconomowoc	8
	45	Mendota	Winnebago	13
	49	Pewaukee	Delavan	14
	52	Delavan	Pewaukee	15
	52	Winnebago	Mendota	17

from Lueschow *et al* (1970)

for comparison. However, it was known that, in general, lake quality was highest in the northern part of the state with a gradual decline in quality toward the south.

Results of this test are shown in Figure 1. The progressive decline in general lake conditions from north to south is shown by the data plot, and the classification methodology was judged to work reasonably well.

In compiling the information necessary for classification, partial input forms were submitted independently from two sources for 89 lakes. (DO information was duplicated for all 89 lakes; transparency and use impairment were duplicated for 21 and 53 of the lakes, respectively.) LCI values were computed for each of the duplicate data forms, and the results were compared to determine the degree of variability that could result from differing data sources. Comparisons of this type were of particular interest because several judgmental decisions are required in preparing input forms, and individual preferences or biases could influence the results. A summary of these comparisons is given below.

Dual input - Effect on LCI values

Same LCI values	57
LCI differs by 1	10
LCI differs by 2	12
LCI differs by >2	10
Total lakes	89

Of the 89 duplicate forms, 57 (64%) resulted in the same LCI values and only 10 (11%) resulted in LCI values that differed by more than 2.

This analysis was carried one step further to determine the source of this variation.

Dual input - Source of differences

Parameter	Same	Different	Total
Dissolved oxygen	76	13	89
Transparency	15	6	21
Use impairment	38	15	53
Total comparison	129	34	163

It was found that if differences occur, the most likely cause is a difference in perception of recreational use impairment. For that parameter, 30% of the answers were

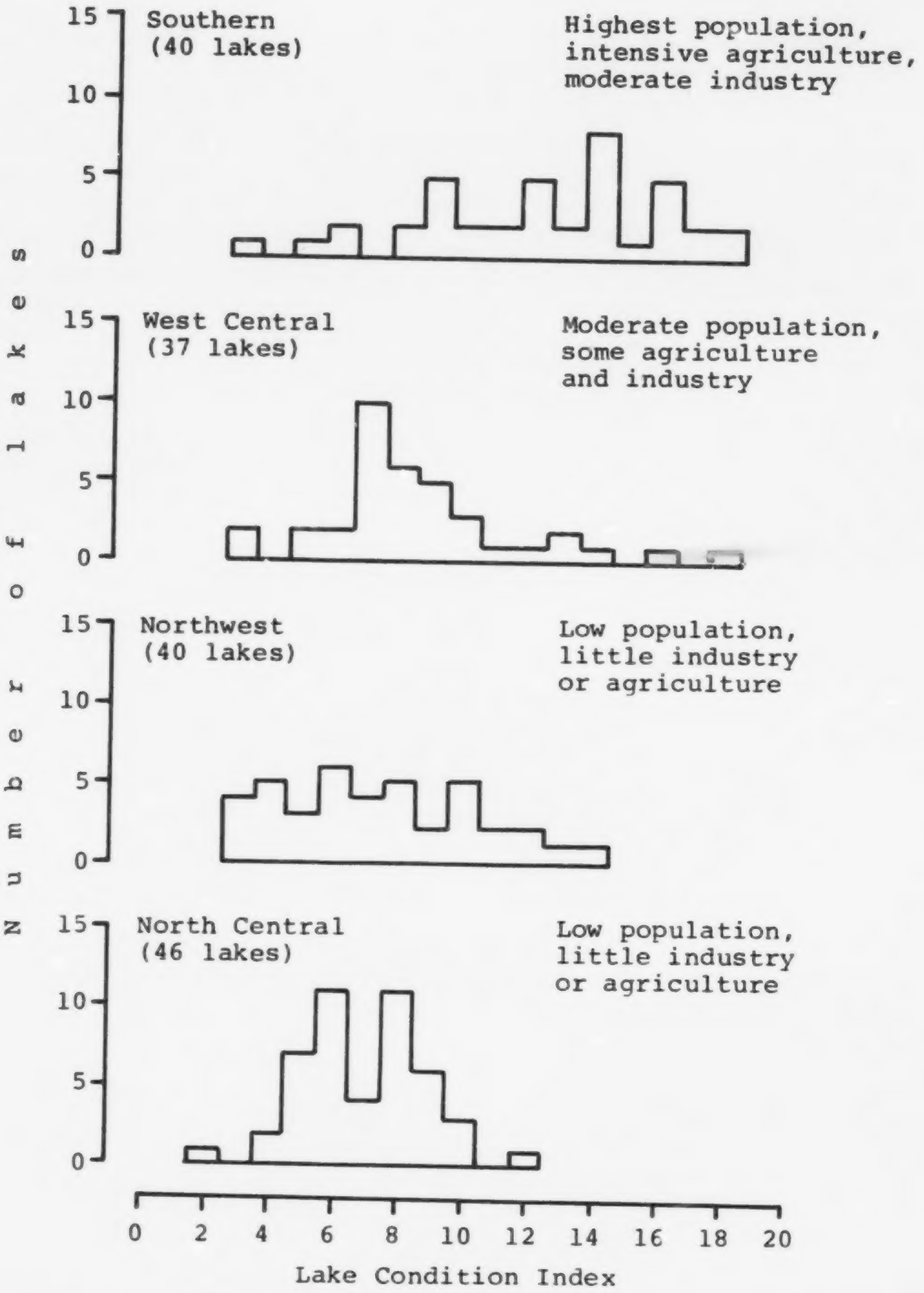


Figure 1. Frequency distribution of lakes by Condition Index for four areas of Wisconsin.

different, perhaps due partly to individual interests and aesthetic values. A fisherman, for example, may not view a weed bed with the same degree of disdain as would a swimmer or pleasure boater. These results led to the "rule of thumb" that LCI values for specific lakes should be viewed as having a possible range of ±2 points.

Based on the generally positive results of these preliminary tests, the classification methodology was left intact, and LCI values were calculated for all lakes in the state larger than 100 surface acres (40 ha). These LCI values are listed in an appendix. Summary results based on 1129 LCI determinations are presented in Figures 2 through 5. Omissions in the data file prevented the calculation of LCI values for 20 lakes. Probable values for 18 of these 20 are given in the appendix, but these values are not included in the summary figures. Whereas inclusion of these data would change the plots slightly, omission of these data has no effect whatsoever on the conclusions.

A frequency distribution based on the numbers of lakes having specific LCI values is shown in Figure 2. The distribution is very much skewed to the left, with more than 50% of the lakes having an LCI of 6 or less. A frequency distribution was also plotted as a function of surface area as shown in Figure 3. Data for Lake Winnebago (LCI = 13, area = 137,708 acres) are not included in this plot because the lake is so large. However, even without the inclusion of these data, there is a shift in the distribution toward the higher LCI values. Whereas only 20% of the lakes had LCI values of 10 or greater, these lakes include 31% of the total area (43% if Winnebago is included). Similar results are shown in Figure 4 in which average lake size is plotted against LCI. As shown on this plot, average lake sizes are much larger at the higher LCI values.

Geographical distribution by county of the study lakes is shown in Figure 5. The average LCI for each county is also presented here. The greatest number of lakes, as well as the higher quality lakes (as indicated by average LCI value), are found in the northern counties. LCI averages tend to increase in the southern part of the state and in those counties adjacent to the Wisconsin River. There are 11 counties with no lakes having surface areas greater than 100 acres; in fact, Crawford County in the southwestern part of the state has only one lake, a four-acre pond, listed in the Wisconsin inventory. Vilas County in northern Wisconsin has the largest number (173) of study lakes of any county, as well as one of the lowest LCI averages (3.9). Several southern counties have LCI averages of 13 or greater.

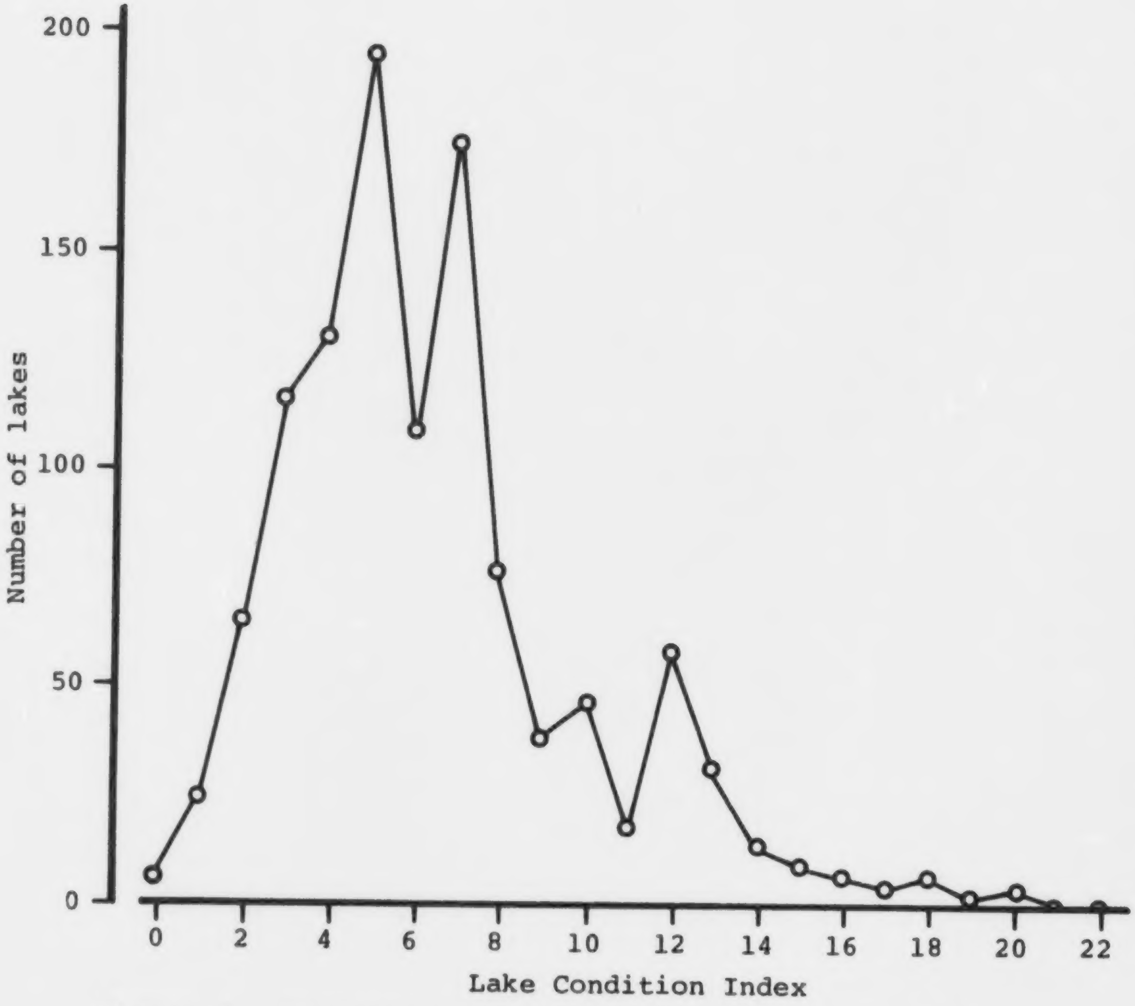


Figure 2. Frequency distribution of Wisconsin lakes according to Condition Index.

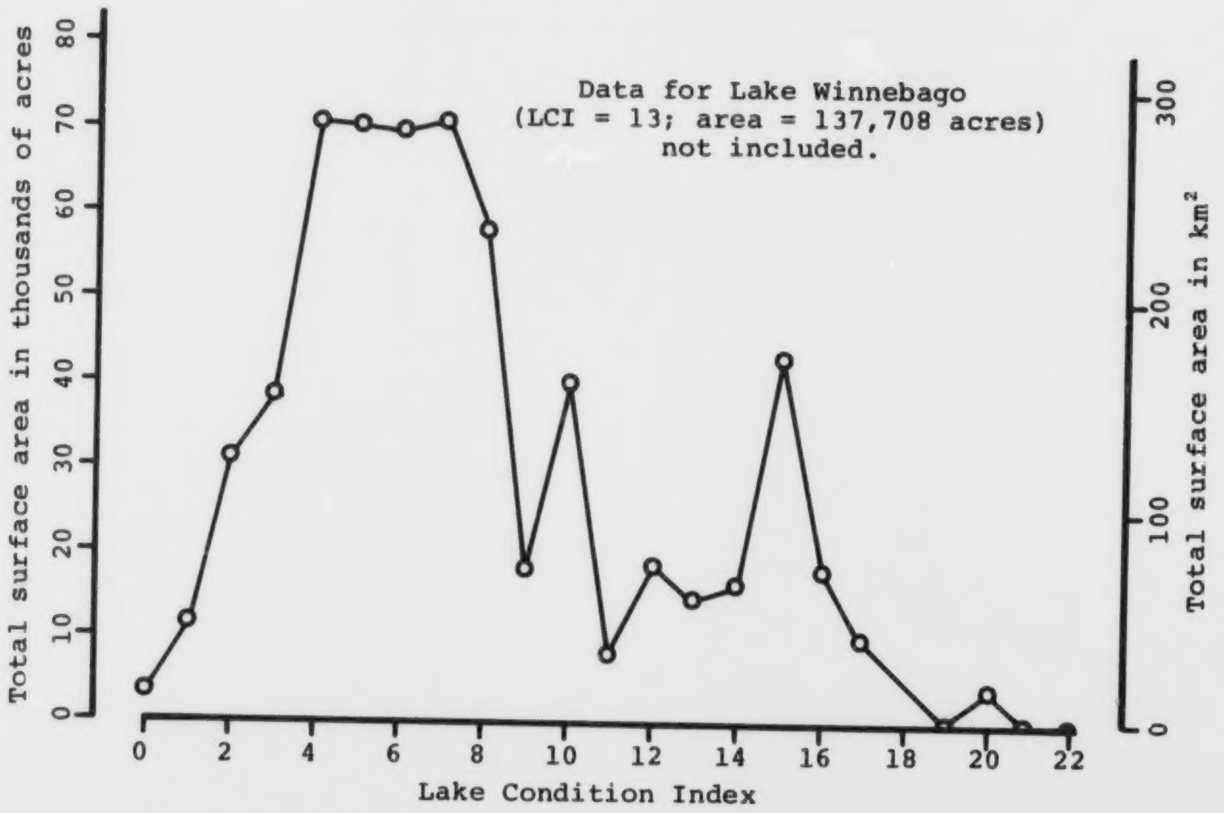


Figure 3. Distribution of surface area of Wisconsin lakes as a function of Condition Index.

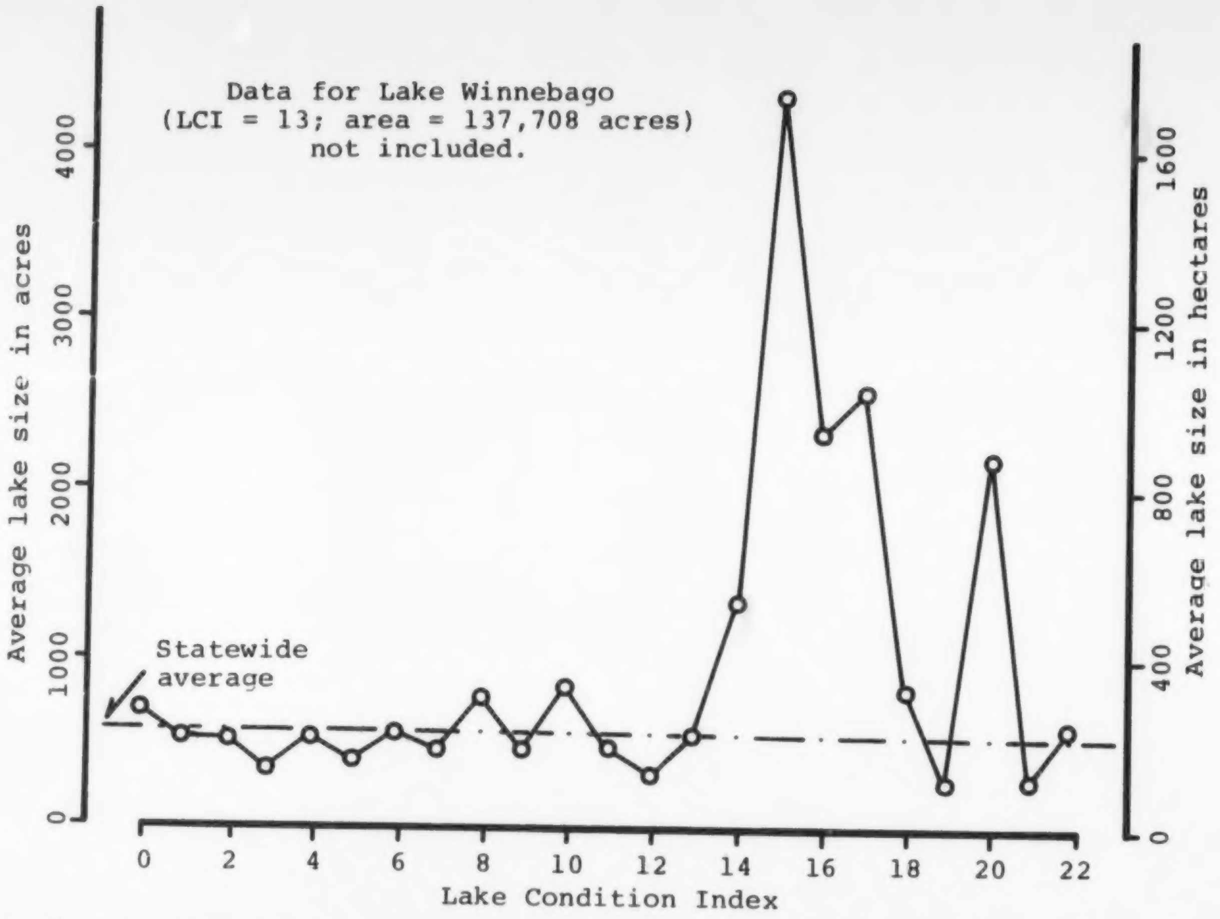
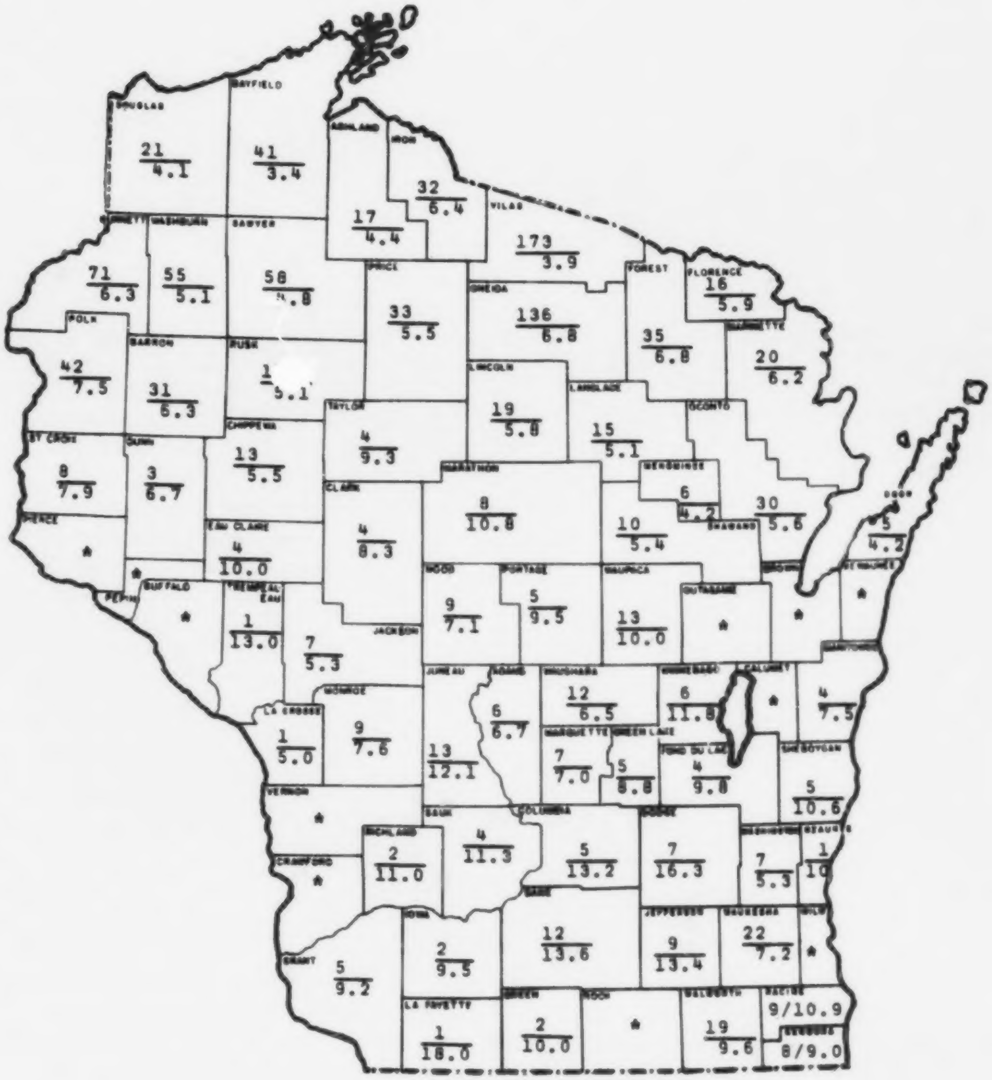


Figure 4. Average surface area of Wisconsin lakes as a function of Condition Index.

Figure 5. Distribution and average LCI of Wisconsin study lakes - by county.


DOUGLAS
21
4.1
BAYFIELD
41
3.4
ASHLAND
17
4.4
IRON
32
6.4
VILAS
173
3.9
BURNETT
71
6.3
WASHBURN
55
5.1
SAWYER
58
4.8
PRICE
33
5.5
ONEIDA
136
6.8
FOREST
35
6.8
FLORENCE
16
5.9
MARINETTE
20
6.2
POLK
42
7.5
BARRON
31
6.3
RUSK
1
5.1
TAYLOR
4
9.3
LINCOLN
19
5.8
LANGLADE
15
5.1
OCONTO
30
5.6
MENOMINEE
6
4.2
SHAWANO
10
5.4
DOOR
5
4.2
ST CROIX
8
7.9
DUNN
3
6.7
CHIPPEWA
13
5.5
CLARK
4
8.3
MARATHON
8
10.8
PIERCE
*
*
EAU CLAIRE
4
10.0
PEPIN
BUFFALO
*
TREMPEALEAU
1
13.0
JACKSON
7
5.3
WOOD
9
7.1
PORTAGE
5
9.5
WAUPACA
13
10.0
OUTAGAMIE
*
BROWN
*
KEWAUNEE
*
LA CROSSE
1
5.0
MONROE
9
7.6
JUNEAU
13
12.1
ADAMS
6
6.7
WAUSHARA
12
6.5
WINNEBAGO
6
11.8
CALUMET
*
MANITOWOC
4
7.5
MARQUETTE
7
7.0
GREEN LAKE
5
8.8
FOND DU LAC
4
9.8
SHEBOYGAN
5
10.6
VERNON
*
RICHLAND
2
11.0
SAUK
4
11.3
COLUMBIA
5
13.2
DODGE
7
16.3
WASHINGTON
7
5.3
OZAUKEE
1
10
CRAWFORD
*
DANE
12
13.6
JEFFERSON
9
13.4
WAUKESHA
22
7.2
MILW
*
GRANT
5
9.2
IOWA
2
9.5
LA FAYETTE
1
18.0
GREEN
2
10.0
ROCK
*
WALWORTH
19
9.6
RACINE
9/10.9
KENOSHA
8/9.0

n = number of lakes in county with areas > 100 acres
n.n = average Lake Condition Index value for county

* = counties with no lakes with surface areas > than 100 acres

Although LCI values are not synonymous with trophic status, additional perception of the condition of Wisconsin's lakes is attained by relating these values to the traditional limnological classifications. With qualification, the following comparisons apply:

LCI	Trophic classification	Number of lakes
0-1	Very oligotrophic	28
2-4	Oligotrophic	308
5-9	Mesotrophic	586
10-12	Eutrophic	125
13-	Very eutrophic	82
		1129

Thus, approximately 30% of the lakes might be considered oligotrophic; 50%, mesotrophic; and 20%, eutrophic.

By comparison, results obtained by the National Eutrophication Survey (U.S. Environmental Protection Agency, 1974) suggest that perhaps a larger portion of the lakes in Wisconsin are eutrophic. As part of the national survey, data were collected from 42 of the same lakes classified here, and these lakes were also classified according to a system developed by EPA. Although quantitative comparisons are difficult because of the relative nature of this latter system, qualitative comparisons are possible by using the relationship between index numbers and approximate trophic status defined for the two systems. On that basis, classifications of the 42 lakes compare as follows:

Lake type	LCI	EPA
Oligotrophic	5	2
Mesotrophic	16	5
Eutrophic	21	35
	42	42

Assessing the adequacy of classification systems is a difficult task because universal definitions for these trophic categories are lacking. In view of this, the LCI approach was subjected to a number of retrospective tests to check the validity of the technique.

One potential problem with the LCI approach, or any technique involving the sum of several numbers, relates to the fact that it is possible to reach the same endpoint classification by many pathways. That is, a given LCI can result from many combinations of penalty points among the four categories. Consequently, it is theoretically possible that very different lakes could have the same LCI value and, if the diversity of lakes within one rank is too large, it negates the value of classification. To check on this potential problem, a graph was prepared in which LCI was plotted against the number of lakes having each of the four DO conditions included in the classification scheme, as shown in Figure 6. (It should be noted that smooth curves were drawn through the data points in this figure; the raw data were more erratic than shown on this plot.) The graph displays the diversity of DO conditions that occur within each of the LCI ranks.

It was found that the four DO conditions were separated reasonably well, although the ranges overlapped as expected. Most lakes with DO condition I had LCI values between 0 and 4, with the peak number having an LCI of 2. This condition describes hypolimnetic oxygen concentrations in excess of 5 ppm and is indicative of oligotrophic lakes. Conditions II and III represent partial oxygen depletion and suggest mesotrophic lakes. These conditions were found to occur most frequently at LCI values of 4 and 6, respectively. Beyond an LCI value of 10, DO condition IV was by far the most common, which suggests that most of these lakes would be eutrophic.

Based on these results, it was concluded that diversity within LCI ranks was not excessive. At most LCI values, a single DO condition can be identified as being the most probable contributor of penalty points. Only in the LCI range of 8-10 is there a significant probability that any of three conditions could be contributors to the LCI.

For another check, the data set was divided into three subsets. First, natural lakes and natural lakes with level controls were separated from impoundments. (Bog and marsh lakes were excluded from this analysis.) Then the natural lakes group was further subdivided according to the type of fishery in the lakes. Two subsets were formed--warm water lakes and warm/cold water lakes. (Only one lake in Wisconsin was listed as a cold water fishery only.) The three subsets were then plotted against the LCI as shown in Figure 7.

The warm/cold water lakes spanned the LCI range from 0 to 8, with the maximum number occurring at LCI = 4. Warm water lakes spanned virtually the entire LCI range, but the majority had LCI values between 2 and 9. LCI values for reservoirs (warm water fisheries, also) covered most of the total range, as well. It was thought that perhaps

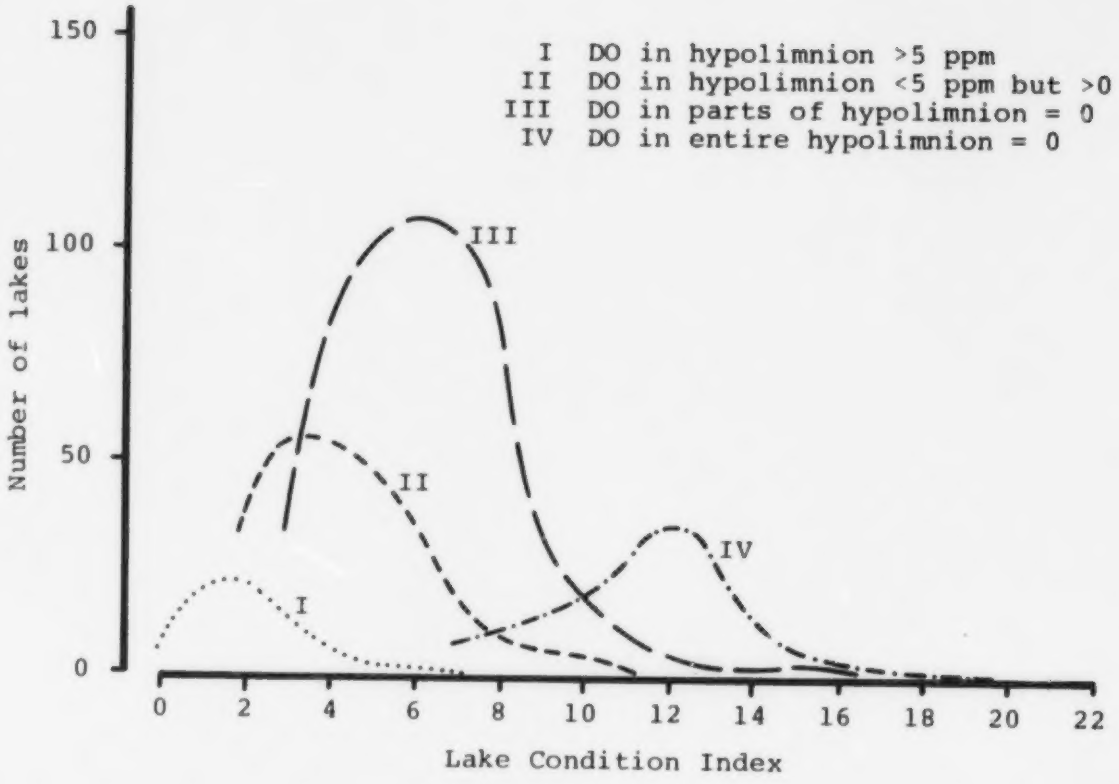


Figure 6. Dissolved oxygen conditions in Wisconsin lakes.

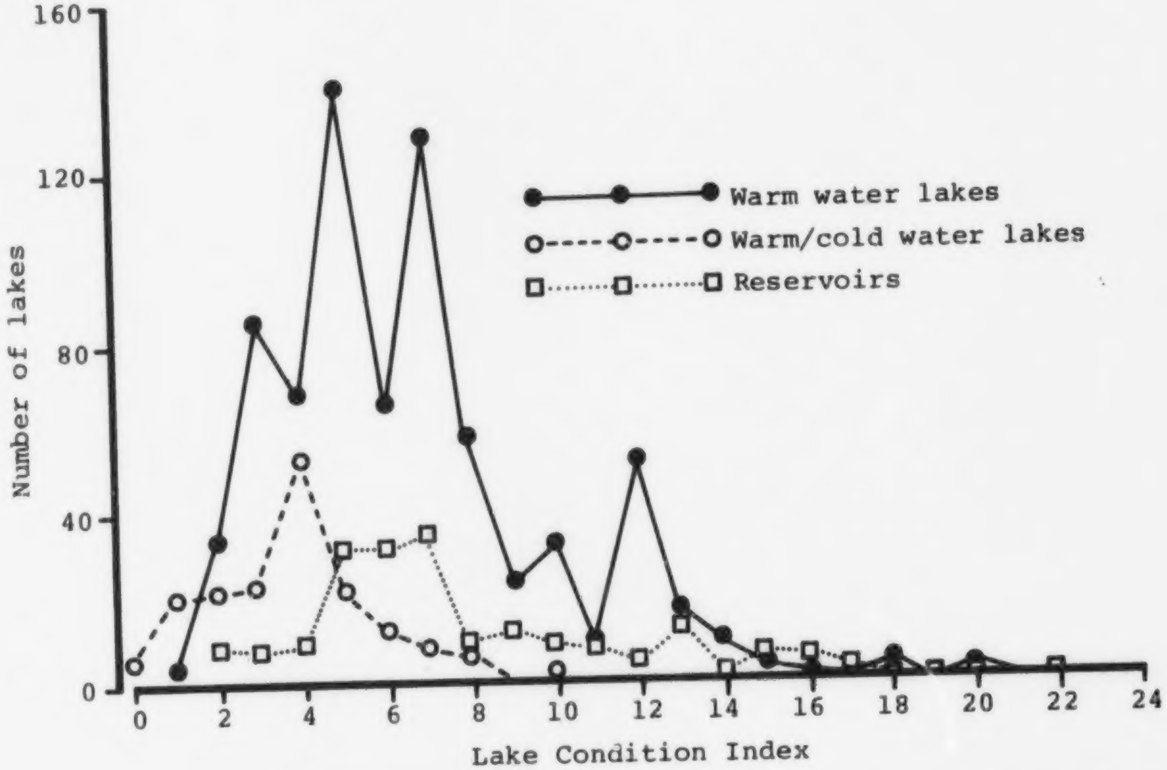


Figure 7. Calculated Condition Indexes for three types of Wisconsin lakes.

impoundments would have lower LCI values than other warm water lakes because flow through the reservoirs often improves DO conditions. This effect is not evident from Figure 7.

Average LCI values for various types of lakes in Wisconsin are given below:

Lake type	Number of lakes	Avg LCI
Warm/cold water fishery	173	3.8
Warm water fishery	739	6.6
Reservoirs	191	7.8
Bog lakes	8	8.0
Marsh lakes	18	12.5
Total	1129	6.5

As a further check, the classification results were distributed to DNR area fish managers. They received a description of the system and LCI scores for the lakes in their area of responsibility. After reviewing the material the managers were asked:

1) to identify those lakes with inaccurate scores;
2) to assign an alternate score if possible; and
3) to furnish information or reasons for any changes.

Nine of the area managers were able to furnish detailed information; seven others were either unable to review the information due to time constraints or reluctance to comment in more than general terms.

The results of their critique are presented below. Table 10 gives an arithmetical breakdown for the nine areas where detailed checks of the LCI results were provided. Total lakes for each area are listed as well as the number of lakes where the fish manager:

1) left the LCI unchanged;
2) changed the LCI by 2 points or less;
3) changed the LCI by 3 points or more.

Table 10. SUMMARY OF CLASSIFICATION SYSTEM REVIEW BY WISCONSIN DNR AREA FISH MANAGERS

Area number	Total lakes	LCI number unchanged	LCI number changed by 2 or less	LCI number changed by 3 or more
1	9	2	6	1
2	42	32	4	6
3	32	20	6	6
4	62	52	7	3
5	84	63	11	10
6	16	11	4	1
7	21	5	10	6
8	23	8	9	6
9	14	9	3	2
Totals	303(100%)	202(66%)	60(20%)	41(14%)

The totals show that of the 303 LCI values reviewed in detail, two-thirds (202) of the values were unchanged. Sixty scores (20%) were changed by two or fewer points which, as discussed previously, is within the estimated limits of the classification accuracy. Forty-one (14%) of the scores were changed by 3 or more points. About 60% of the changes resulted in higher LCI values. In most instances it was found that out-dated or inaccurate input data caused these large discrepancies in LCI values. In eight cases, however, the system itself was responsible for distorted lake scores. The system does not take residence time into consideration when awarding penalty points for dissolved oxygen conditions. Consequently, a few reservoirs of poor water quality, but with high flow rates, received lower LCI scores which placed them in the same category as lakes judged to have much higher water quality.

Some of the area managers who did not have time to review the classification results in detail nevertheless furnished some subjective commentary. Most thought the system was generally satisfactory. Three cited the tendency of reservoirs with high flow rates (as discussed above) to be "forgiven" their poor water quality. Four managers suggested that methyl-purple alkalinity values should be included in the system as an indicator of fertility or production potential. Two others felt the use impairment parameter was too subjective as it is presently phrased. These managers said the wide range of individual interests clouded the value of this particular bit of information, and suggested that the question pertaining to nuisance algae and excess rooted aquatics be reworked to make it more quantitative. While the project staff would have preferred specific, detailed reviews from all the area fish managers, it is estimated that the number and extent of changes in LCI scores would have been close to the percentage summarized in Table 10.

In summary, it appears that the results of the LCI determinations for the more than 1100 lakes in the study set provide a good perspective of the water quality conditions in these lakes.

SECTION VI

LAKE CLASSIFICATION FOR DECISION MAKING

From the outset in this report, lake classification was viewed as a dynamic rather than static concept. Lake classification is not an activity which should be undertaken with the idea that after some finite period of time the job will be done and all the lakes will be classified. Far greater benefit can be attained by repetitive classifications designed to address specific management needs. In this chapter an attempt is made to illustrate the utility of this philosophy of approach by citing specific examples in which dynamic classification can be used to advantage. The examples given below are not abstract ideas; most are the outcome of discussions with resource managers concerned with how lake classification could be of value to them in solving problems or identifying opportunities for improved management.

Two fundamental concepts underlie each of the examples given below.

1) A single comprehensive classification system, capable of taking into account all the diverse management interests and objectives of today or of the future, does not exist now, nor is it likely to exist at a later time. However, it is possible to substitute for this, at least in part, by utilizing cross-comparisons of several single-purpose classification systems which are presently operational or can be developed without undue difficulty.

2) Lake classification systems need not consist of rules, guidelines or equations which are so broadly defined that they are applicable to all lakes in all settings. An equally valid, but often more advantageous, classification approach is to define those lake characteristics or properties which are of interest for the specific purpose at hand, and then segregate that subset of lakes which possesses the desired traits. The concept of

delineating special-purpose subsets greatly enhances the usefulness of lake classification.

The above approach envisons the existence of an information base from which one can retrieve selected information. By analogy, this is quite similar to the approach presently being used in the area of literature retrieval. Subject indexes (static classification) have proven to be inadequate tools for searching and retrieving selected topics from the literature because it has not been possible to define a suitable indexing system which segregated entries in accord with all the diverse interests of user groups. Thus an approach has been developed in which "key words" or "descriptors" are assigned to all entries in the data base, and custom searches are then performed by selecting that subset of items from the data base which possesses all the predetermined key words deemed to be significant for the purpose at hand. Thus a new "classification system" is devised for each user (dynamic classification). In a sense, this approach is the simplest type of classification--pre-set grouping which has only two groups: those items which are of interest, and those which are not. The key to success is a flexible data base which contains items of interest and a mechanism by which selected items can be retrieved. In the examples below, the lake data for Wisconsin are available either from the information compiled as part of this classification effort or are available from a lake information base maintained by the Wisconsin Department of Natural Resources. In each case, the data are stored on magnetic tape, and computer programs can be written to retrieve selected information.

As suggested earlier in this report, an improved perspective of lake management priorities results when lake condition and nutrient loading (the latter as a measure of likelihood for change, either natural or man-made, desirable or undesirable) are viewed simultaneously. In its simplest form this may be viewed as a 2x2 matrix consisting of four different lake sets.

Set	Specific loading	LCI	General water quality management grouping
a	low	low	No present danger
b	low	high	Renewal desirable; long-term benefits may be possible without extensive nutrient abatement
c	high	low	Prompt protection needed; degradation may be imminent
d	high	high	Problem lakes; renovation desirable but lasting improvement may require extensive nutrient abatement

Set a) These lakes of high quality would be identified as unendangered. The management approach for these lakes might be to maintain the status quo, i.e., protection to avoid degradation. The condition of these lakes would be expected to be quite stable; thus some of them might be considered for inclusion in monitoring programs designed to measure "background levels" of chemical constituents. Also, by the addition of information relating to public access, shoreline development, public ownership, etc., some of these lakes could be selected for special purpose management, such as "wilderness" recreation areas.

Set b) Lakes in this group would be prime candidates for lake renewal efforts because of the possibility for lasting improvement. In-lake renewal techniques, such as aeration, sediment manipulation, etc., could yield long-term benefits in this type of situation because the influx of nutrients from external sources is small. This might be a particularly advantageous approach if there is reason to believe that prior actions (such as the improvement of upstream waste treatment facilities) have reduced present levels of nutrient influx below levels which occurred previously.

Set c) The condition of lakes in this group would be expected to be unstable and progressing toward further degradation. Based on the general consensus that eutrophication prevention is better understood than eutrophication reversal, and that preventive management may be more economical than restorative measures, these lakes require protective action with some degree of urgency. Nutrient removal from wastewaters in the drainage basin could be a high priority consideration.

Set d) The lakes in this group are not only fertile, but also receive high inputs of nutrients. Extensive nutrient abatement may be required before long-lasting lake rehabilitation could be anticipated. Perhaps the immediate focus of management for these lakes should be to ease the symptoms of excess fertility and to direct use toward those activities compatible with fertile waters until renewal techniques are more refined and related costs and benefits are better defined. Another option would be to manage the lake and shorelands as fertile areas, emphasizing environmental diversity and high productivity as positive attributes.

By noting the number of lakes in each set, their size, and perhaps auxiliary parameters, such as the proximity to population centers, some general management priorities can be ascertained. For example, if the majority of a state's lakes fall into sets c and d, a concerted program of nutrient abatement would be of high priority. If the majority of lakes fall into group b, the development and refinement of in-lake renewal techniques might be a high priority objective. Of course, a clean distinction between "high" and "low" levels of the parameters used in developing the 2x2 matrix may be difficult to establish, and selected levels would certainly be open to debate. Some provisional guidelines were presented by Vollenweider (1968). However, these guidelines are based on data from 30 large lakes (12 from central Europe, 10 from North America, and 8 from northern Europe), and their direct applicability to smaller lakes or specific geographic areas has not been established.

Table 11. SPECIFIC LOADING LEVELS FOR LAKES EXPRESSED AS TOTAL NITROGEN AND TOTAL PHOSPHORUS IN $g/m^2/yr^a$

Mean depth up to:	Permissible loading, up to:		Dangerous loading, in excess of:	
	N	P	N	P
5 m	1.0	0.07	2.0	0.13
10 m	1.5	0.10	3.0	0.20
50 m	4.0	0.25	8.0	0.50
100 m	6.0	0.40	12.0	0.80
150 m	7.5	0.50	15.0	1.00
200 m	9.0	0.60	18.0	1.20

[a] from Vollenweider (1968)

The same general approach described above can also be developed by considering the relationship between nutrient loading and lake condition as a continuous function rather than one which can be split neatly at predetermined breakpoints. This approach avoids the necessity of specifying high and low levels for nutrient loading rates and lake condition values. In this case the 2x2 matrix is replaced by a plot of nutrient loading versus lake condition as shown in Figure 8.

Abscissa values shown in Figure 8 are LCI numbers. The ordinate values shown are

$$\frac{\text{P-loading}}{\left(\dfrac{\text{Mean depth}}{\text{Hyd res time}}\right)^{\frac{1}{2}}}$$

The selection of this parameter is based on some of the more recent work of Vollenweider (in press). "Normalizing" the loading rates to account for depth and hydraulic residence time would be expected to reduce data-scatter and make it easier to define an empirical relationship between the selected parameters.

Although LCI values have been calculated for many Wisconsin lakes, nutrient loading data are, for the most part, lacking. Therefore, Figure 8 is a hypothetical sketch which is included to illustrate the general approach; it is not a plot of actual data.

One of the principal advantages of this approach is the development of loading-condition relationships which are applicable in specific geographic regions. Then, by selecting LCI values which represent satisfactory or unsatisfactory lake quality, permissible or dangerous loading rates can be specified. An analysis very similar to this was conducted by Shannon and Brezonik (1972). Based on data from 55 lakes in Florida, they reported permissible areal loadings of 2.0 and 0.28 $g/m^2/yr$ and critical loadings of 3.4 and 0.49 $g/m^2/yr$ for nitrogen and phosphorus, respectively. These values are considerably higher than the provisional values reported earlier by Vollenweider (1968) and indicate that, for conditions in Florida, somewhat higher levels of nutrient influx can be tolerated without detrimental effects.

The four lake subsets described earlier for the 2x2 matrix can also be identified from a plot such as that given by Figure 8. Data points on the left side of the plot represent lakes which are presently of high quality; those on the lower-left would appear to be unendangered; whereas those in the

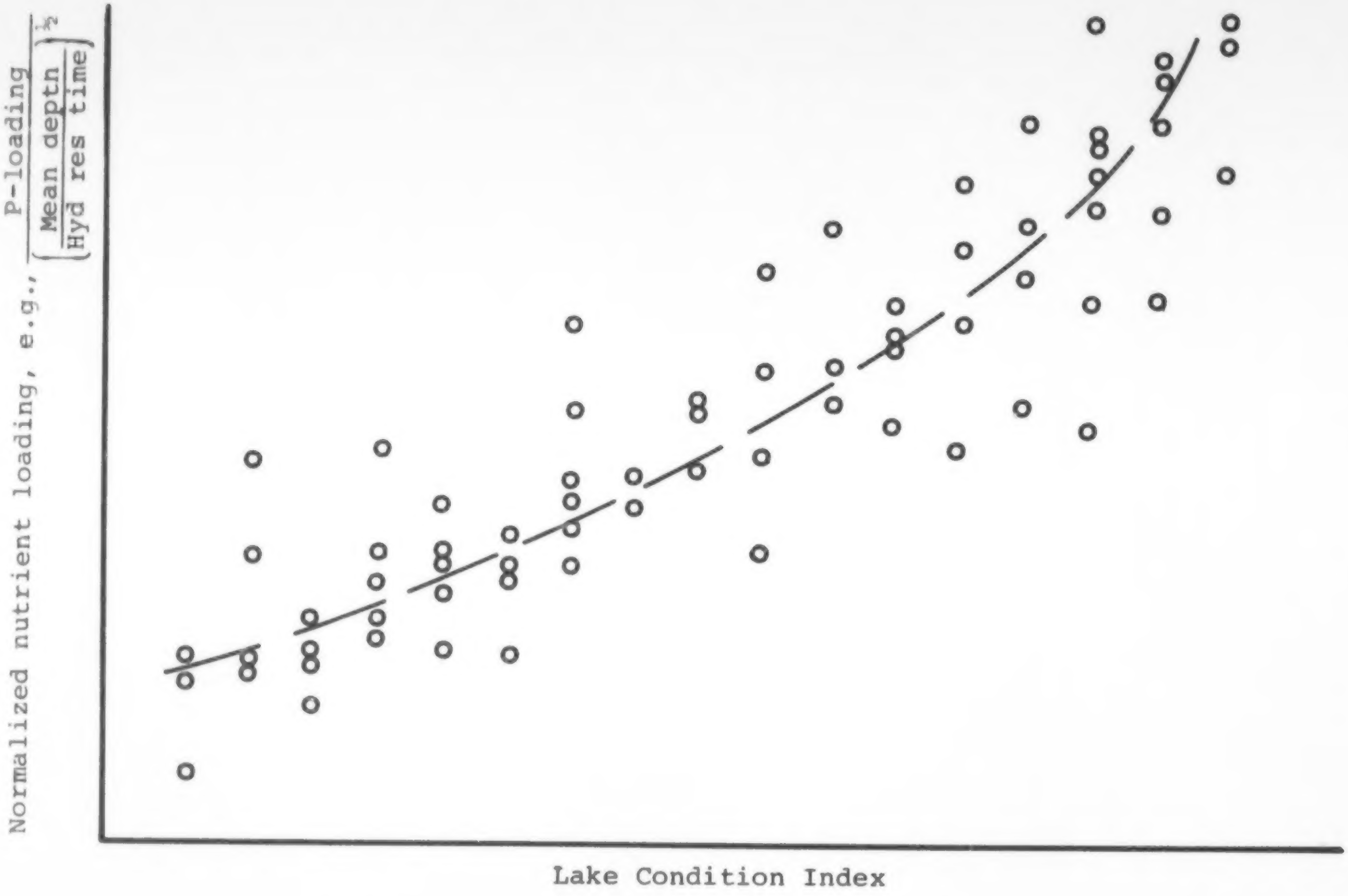


Figure 8. Relationship between nutrient loading and lake condition (hypothetical data).

upper-left might be subject to imminent degradation and in need of prompt protective action. Lakes in need of renewal are on the right side of the plot, and the prime candidates would be those with the lower nutrient loadings.

Nutrient abatement is a logical and necessary part of any lake renewal effort. To assess the cost-effectiveness of abatement measures it is necessary to specify the degree of water quality improvement corresponding to achievable levels of nutrient reduction. The establishment of loading-condition relationships provides a basis for quantifying the degree of anticipated improvement (or conversely, the degree of degradation which could occur if abatement is not undertaken or if nutrient loading would increase).

The dashed line in Figure 8 represents the stable or equilibrium relationship between nutrient loading ("normalized") and the lake condition index. Obviously, the process of eutrophication is far too complex to be expressed uniquely by these two parameters, and thus some degree of data-scatter would be expected. However, as a first approximation, one would expect a change in nutrient loading to shift the position of a data point along a path parallel to the dashed line. Since the abscissa values are a measure of readily-interpretable lake conditions, Figure 8 provides a conceptual framework for estimating the extent of nutrient abatement necessary to achieve desirable lake quality or the degree of improvement which corresponds to a given level of abatement.

At the present time, lake renewal can be described as an emerging science consisting of two major aspects. One aspect relates to the nutrient supply of lakes, with renovation techniques being aimed at reducing the influx of nutrients from external sources. The other aspect of lake renewal relates to in-lake treatment or manipulation for the purpose of minimizing or eliminating the undesirable effects of excess fertility. These latter approaches are sometimes considered to be palliative because they are aimed at treating symptoms and do not eliminate the source of the problem--excess nutrient influx. Nevertheless, there are many situations in which in-lake renewal schemes can be used to advantage for hastening the recovery of a lake where nutrient abatement has been accomplished, or for improving the quality of those lakes where the desirable reduction in nutrient influx is not feasible. Also, long-lasting effects of in-lake techniques, such as hypolimnetic aeration and nutrient precipitation/inactivation, are possible in those situations where repetitive internal nutrient cycling contributes significantly to a lake's nutrient status. Because of these possibilities, research and demonstration projects are being conducted on a number of lakes throughout the world (Dunst *et al*, 1974) to evaluate various in-lake renewal schemes.

One measure of the need and priority for developing in-lake renewal techniques relates to the potential applicability of any scheme: that is, how many lakes or how many acres of water could potentially be restored or improved by the use of a particular technique? For the most part, assessments of this type have not been made on either a state or national level. Lake classification can be used to advantage in making these assessments. The logical groups of lakes to be considered in this type of analysis are lake sets b and d defined earlier in this section.

Fortunately, the potential applicability of a number of in-lake renewal techniques--namely, dredging, hypolimnetic aeration, nutrient inactivation/precipitation, and selective discharge--can be defined in terms of the physical setting or characteristics of lakes. Classification techniques using a relatively modest data base can thus be used to "sort out" candidate lakes whose characteristics match the prerequisite conditions of the various renewal schemes.

Hypolimnetic aeration is a technique which provides for the maintenance of dissolved oxygen in the bottom waters of lakes during periods of stratification. Thermal stratification is maintained, making it possible for cold-water fish species to survive. At the same time, aerobic conditions in the hypolimnion tend to reduce the transfer of nutrients and other dissolved substances from the sediments to the overlying water and, therefore, some water quality improvement can result because of the disruption of internal chemical cycles. Lake characteristics necessary for the successful use of hypolimnetic aeration include:

1) maximum depth in excess of 25 feet (8 m);
2) strong, stable stratification during summer months;
3) oxygen-void hypolimnion; and
4) area of less than 1000 acres (400 ha).

The first three items are necessary conditions, whereas item 4 is a practical constraint that is subject to change depending on the type of equipment available. By "sorting" the characteristics of lake sets b and d to determine how many are smaller than 1000 acres, deeper than 25 feet, stratified during the summer and experience oxygen depletion in the hypolimnion, one obtains a measure of the potential applicability of hypolimnetic aeration as a lake renewal technique. The same approach can also be used for other renovation methods.

Precipitation processes using iron, aluminum and calcium compounds to remove phosphorus from wastewater have become standard practice. Adaptations of this technology to lake renewal have been evaluated in laboratory studies (Peterson *et al*, 1974) and field demonstrations (Dunst *et al*, 1974). Experience to date indicates that the technique is most successful on lakes which are stably stratified during the summer growing period--intermittent summer stratification appears to lessen the effect of treatment by permitting nutrient recycling. However, phosphorus reduction in the hypolimnion of Horseshoe Lake (Wis) was sustained for three years following treatment (Born *et al*, 1974) even though the lake underwent complete overturn several times during that period.

Criteria for nutrient inactivation/precipitation include:

1) maximum depth in excess of 15 ft (5 m);
2) stratification occurring throughout the growing season;
3) present lake problems relating to algal growths, not rooted vegetation; and
4) hydraulic residence time of one year or longer. (This criterion could be related to drainage basin/lake area ratios if flow data are lacking.)

Dredging to remove nutrient-rich sediments (as opposed to dredging simply to make a portion of a lake deeper) is generally considered to be a viable lake renewal technique. It is known that lake sediments often contain large quantities of nitrogen and phosphorus and, in some cases, the recycling of these nutrients to overlying waters can have a significant impact on the nutrient status of lakes. Dredging could reduce nutrient recycling if sediments were removed down to mineral soil, or if sediment characteristics vary with depth such that, by skimming off the upper layers, nutrient transfer to overlying waters is lessened. However, except for results attained at Lake Trummen in Sweden (Bjork,1972), studies documenting the effect of dredging on the nutrient status of lakes are lacking.

Dredging would be expected to be most successful in lakes which have accumulated layers of organic sediments as a remnant of past production in the lake proper. Lakes which receive large sediment loads from land runoff may be benefitted by dredging because it provides increased depth. However, dredging may have a minimal influence on the nutrient status of these lakes, and thus the value of dredging as a lake restoration technique is not likely to be great.

Classification criteria for evaluating the potential applicability of dredging as a lake restoration measure include:

1) lakes in which 50% or more of the area has a depth less than 8 ft (2.5 m);
2) landlocked lakes, or lakes with outlets only;
3) lakes with bottom materials consisting primarily of mud or silt; and
4) lakes with problems related to excessive rooted aquatic vegetation, not algae.

Criteria for other in-lake renewal techniques could be developed as well; however, the examples given above are sufficient to illustrate the usefulness of lake classification as an assessment tool. Each of the criteria sets listed above defines a pre-set, grouping classification system that can be used to sort the information base for those lakes judged to be in need of restoration (i.e., sets b and d defined previously). Those lakes which satisfy the criteria for each of the renewal techniques are identified, and a comparison of the results provides a measure of the applicability of the different techniques. (Note: A lake may be identified as having characteristics which meet the criteria for more than one renewal technique; the criteria are not mutually exclusive.)

Of course, the lists of lakes generated by this approach are only a crude measure of the applicability of lake restoration methods. Virtually all of the techniques have site-specific requirements which must be evaluated before the applicability of a technique can be established. For example, the settling characteristics of sediments from a given lake and the availability of a sediment disposal site must be known before dredging could be seriously considered as a renewal measure. Nevertheless, lake classification provides a start toward evaluating the applicability of dredging and, of equal importance, eliminates those lakes for which dredging is inappropriate and acquisition of site-specific information is unnecessary.

This latter type of classification in which a data base is sorted to identify potential candidates (and, of equal importance, to eliminate unlikely candidates) can be used to advantage in resource planning. A good example of this arose in connection with the designation of scientific areas in Wisconsin. A program has been initiated with the general purpose of identifying, designating, and preserving a variety of "undisturbed areas" which could serve as baselines or control areas for environmental studies. Emphasis is placed on areas which are sheltered from human influence and exhibit a high degree of diversity in both plant and animal populations, including rare or endangered species. Although criteria for the selection of scientific areas have been worked out in some detail, selection of areas is difficult because there exists no data base which includes the specialized information and the degree of detail necessary to apply the criteria directly. The necessity of collecting field data cannot be avoided entirely, but lake classification can be used to select a set of candidate lakes which includes possible scientific areas.

In this case, a logical starting point is to conduct cross-comparisons of lake condition, nutrient loading, and density of shoreline development. The first two comparisons have already been discussed, and likely candidates for scientific areas would be found in set a (low LCI, low loading rates). This group can then be further reduced by reclassifying the lakes according to development density--dwellings/mile of shoreline, or acres of water/dwelling. This latter step could also include public ownership as part of the classification criteria. The end product of such an effort is a list of potential scientific areas. Further reduction of this list would require additional data; quite possibly field examinations of each site would be necessary. However, by utilizing a more general data base and applying lake classification concepts, it is possible to expedite the selection of lakes for highly-specialized purposes, even though the data bank may not contain all the information necessary for the final decision.

Parameters relating to the extent of shoreline development--either actual or potential--are likely to be included in many lake management decisions. In some cases, such as the example of selecting scientific areas, development density may be a prime consideration. This is likely to be true in only a minority of situations, however. Development density is likely to be more important for establishing priorities or ranking lakes within a group which has been selected on the basis of other parameters. For example, if a field demonstration of nutrient inactivation/precipitation were to be undertaken, the selection of candidate lakes could be accomplished with the use of the classification criteria discussed previously. Then, the selection of high-priority candidates could be based on development density, to introduce the dimension of benefitting the maximum number of people.

Because of the potential usefulness of development density as a lake classification parameter, a classification of Wisconsin lakes according to development density was undertaken. The analyses were conducted by the Wisconsin Department of Natural Resources and are based on data collected by that agency.

For purposes of this study, it was decided that development density would be defined in two ways, as 1) dwellings per mile of shoreline and 2) surface acres of water per dwelling. The DNR lake inventory file contains survey data which were compiled over the period 1959-1972. This computerized file contains an entry for the number of cottages and the number of resorts (up to a maximum of 9 resorts) on each given lake. In this analysis, a resort was defined to be equivalent to 5 cottages, so the total number of dwellings was equal to the number of cottages plus 5 times the number of resorts.

A summary of the results of this study is given in Table 12. The data set used in this analysis included all lakes in Wisconsin with surface areas of 20 acres (8 ha) or larger. As shown in the right-hand column of the table, this included 2790 lakes having a total shoreline of 8797 miles (14,160 km) and a total area of 761,000 acres (308,000 ha).

Eleven different ranges of development density are shown in Table 12. With respect to length of shoreline, the lowest range given is 0-5 dwellings/mile; the highest range includes all density values in excess of 50 dwellings/mile. If it is assumed that most dwellings occupy about 100 feet (30 m) of shoreline, then the lowest range given would include those situations in which the total shoreline is about 10% "developed"; likewise, the highest range is equivalent to 100% development. Of the 2790 lakes in the sample, 1926, or 69%, had 5 or less dwellings per mile of shoreline. These lakes have a total shoreline of 5411 miles (8712 km) which is equivalent to 61.5% of the total shoreline in the sample lakes. Based on these results it would appear that the lakes in Wisconsin are relatively undeveloped, and the potential for additional development may be quite high. However, the perspective is changed radically when viewed from the standpoint of lake area.

With respect to lake area, the highest density range given is 0-10 acres/dwelling, and the lowest includes all values in excess of 100 acres/dwelling. The analysis showed that 1881 lakes (67.3% of the total number) had 10 or less surface acres per dwelling, and that lakes developed to this density account for more than half of the total acreage of the study lakes (409,000 acres out of a total of 761,000).

Table 12. DEVELOPMENT DENSITY OF WISCONSIN LAKES

	Development density in dwellings/mile of shoreline											
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	Over 50	Total*
Number of lakes	1926	348	183	112	38	32	25	24	14	16	52	2790
Percent of total	69.0	12.5	6.3	4.0	2.1	1.1	0.9	0.9	0.5	0.5	1.9	100
Miles of shoreline	5411	1368	906	369	232	139	96	61	46	50	119	8797
Percent of total	61.5	15.5	10.3	4.2	2.6	1.6	1.1	0.7	0.5	0.6	1.4	100

	Development density in surface acres/dwelling											
	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	Over 100	Total*
Number of lakes	1881	343	203	122	72	47	31	16	16	14	45	2790
Percent of total	67.3	12.3	7.3	4.4	2.6	1.7	1.1	0.6	0.6	0.5	1.6	100
Area (thousands of acres)	409	131	38	55	16	7	6	16	22	4	56	761
Percent of total	53.8	17.2	5.0	7.2	2.1	0.9	0.8	2.1	2.9	0.6	7.4	100

*Wisconsin lakes 20 acres or larger

The meaning of this development density becomes more clear when it is compared to criteria used to estimate the "recreational carrying capacity" of lakes.

To minimize use-conflicts and provide for high-quality recreational experiences, resource managers have attempted to specify minimum space requirements for the different recreational uses of lakes. The values listed below are perhaps somewhat arbitrary and subject to debate; however, they are based on logical rationale and, when applied with judgment, they can be used to calculate the carrying capacity of a lake for various uses.

Activity	Space requirement
Swimming	185 swimmers/acre
Fishing	8 acres/boat
Boating	15 acres/boat
Water skiing	20 acres/boat

after Wisconsin Department
of Natural Resources (1968)

Some assumptions regarding use-frequency must be made before these tabulated values can be compared to the development density data, but it would appear that riparians alone could exceed the recreational use capacity for boating and water skiing on those lakes where the development density is in the range of 0-10 acres/dwelling. And, this accounts for more than 50% of the lakes in the study group.

Based on these data, it appears that most Wisconsin lakes are developed to the point that additional recreational development could place stress on users and, possibly, on the resource itself. On the other hand, there are 566 lakes in the sample which have more than 20 acres/dwelling, and 169 of those have more than 50 acres/dwelling. If recreational home development is to continue, it might be advantageous to direct future development toward these lakes. Alternatively, a policy could be adopted which would direct future development to lakes which are already "crowded" on the basis that some measures to protect water quality, such as wastewater collection and treatment facilities, are more easily implemented in densely populated areas; and it may be better to "sacrifice" the quality of recreational experiences on some lakes in order to retain it on others. Other variations are also possible; the point to be made is that lake classification can be used in a variety of ways to provide an improved perspective of management issues and to lend a degree of quantification to the decision-making process. Significant lake classification can be accomplished with a modest information base, and it is a technique which can, and should, be used more frequently as a tool for improved resource management.

SECTION VII

REGIONAL APPLICATION OF THE LCI SYSTEM

This project was a test of the paired hypotheses that:

1) a practical classification system could be developed by which lakes could be ranked according to general water quality characteristics; and
2) sufficient data and information could be compiled to permit classification of large numbers of lakes.

These hypotheses are strongly interrelated: data availability placed a major constraint on the type of classification system that was developed; and, conversely, the need to describe lake conditions encompassing both time and space variables dictated minimum data requirements.

A methodology for lake classification was developed and used to classify all lakes in Wisconsin having surface areas in excess of 100 acres. Based on these efforts, it was concluded that the hypotheses were affirmed; however, conclusive "proof" could not be obtained in the strict scientific sense because there is no solid baseline for assessing the "accuracy" of a lake classification system. As a substitute, the adequacy of the system was checked by using several subjective tests. Based on these tests it was concluded that: 1) the results compare favorably to those of more complicated systems which require considerably more input data; 2) the system yields nearly the same results even though different individuals provide input information; and 3) the data requirements are sufficiently minimal that costs of compiling the necessary input are not prohibitive. In addition, the relative position of ranked lakes was judged to be reasonable when viewed by area resource managers, and a breakdown of lakes according to fishery types proved to be consistent with computed condition index values. In short, the general approach and the classification scheme worked well for Wisconsin lakes larger than 100 acres.

The potential applicability of this classification scheme to other parts of the country can only be approximated, but an estimate can be made by examining the individual parameters included in the system.

1) dissolved oxygen in the hypolimnion - Stratification is implicit in the definition of this part of the classification system. Thus, shallow lakes which undergo frequent or continuous overturn and reservoirs in which stratification is dominated by flow-through characteristics receive few "penalty points" or none at all. Therefore, these lakes are not separated by dissolved oxygen considerations, and greater reliance is placed on the other parameters in the classification scheme.

2) fishkills - This is another consideration of dissolved oxygen conditions but, unlike the one above, this refers to a depletion of oxygen throughout an entire lake. In north-temperate lakes this condition occurs under ice cover, and the occurrence of winterkill conditions in a lake is often indicated by the fish species present, i.e., a fishery dominated by those species which can tolerate low oxygen concentrations. Thus, winterkill conditions can be documented after the fact--a distinct advantage for data acquisition. Although winterkill is a useful parameter only in regions where lakes are ice-covered, the analogous condition of "summerkill" would probably be a useful parameter in more southerly locations. In this case, decay and respiration following periods of intense organic production can reduce dissolved oxygen concentrations to levels lethal to fish. Like winterkill, lake morphology also plays an important role in summerkill by influencing the degree of oxygen depletion resulting from a given level of oxygen demand, and some measure of morphology (e.g., mean depth) should be included in the classification routine.

3) typical maximum and minimum Secchi depths - Secchi depth information is, to a large extent, universally useful; however, interpretation is different if changes in measured water clarity are due to inorganic rather than organic particulate matter. Water color also influences Secchi depths somewhat, but it is expected that the usefulness of this parameter is not restricted to any particular region of the country.

4) impairment of use (extent to which algal blooms and rooted aquatic vegetation interfere with uses of a lake)- The conditions described for this parameter are sufficiently general that they would probably apply to most

regions of the country. However, variations in public perception of water quality are likely to introduce regional variations. For example, a "weed-choked" lake in one place may be a relatively "weed-free" lake in another, depending on the local norm.

Considering the type of regional differences that are likely to affect the use of the classification system reported here, it appears that the country may be divided into three general zones: 1) states where the system might be applied without modification, 2) states where minor changes may be desirable, and 3) states where major changes might be needed. It is estimated that the classification system reported here could be applied directly in the northern tier of states extending eastward from the Dakotas to the Atlantic Coast. The system may need some modification in the mountain states of the West and the band of states extending eastward from Kansas. The system is likely to be least applicable in the warm South and Southwest.

Extending this analysis a bit further, it is possible to estimate the number of lakes that lie in each of the three regions described above. (See Table 13.) Based on a compilation of lake inventory data from each of the states, it is estimated that 9503 lakes larger than 100 acres could be classified by the technique reported here, and an additional 2073 large lakes could probably be classified if the system were modified somewhat. Although there is no national lake inventory, a summation of the state inventories shows that there are at least 94,877 lakes in the country, and, of these, 13,599 are larger than 100 acres in size. Therefore, about 70% of the larger lakes could potentially be classified by the technique reported here, and it is estimated that an additional 12% of the total could be classified if the system were adjusted. Considering all lakes, 56% of the total lie in the 18 states in which the system is thought to be directly applicable, and an additional 32% lie in the 20 states where some modification of the system may be desirable. Thus, even though the approach used here may have regional restrictions, it is still likely to be applicable to most lakes in the country.

If the classification system developed here is, in fact, applicable to a distinct majority of the nation's lakes, would it be sufficient to meet all classification needs? The answer clearly is no. Systems based on subjective information cannot be used as permanent replacements for data-based systems. The ultimate necessity of obtaining field data, quite possibly on a repetitive basis, cannot be avoided. However, by using a subjective approach as

Table 13. APPLICABILITY OF LAKE CLASSIFICATION SYSTEM[a]

	Large lakes[b]	Total lakes
Direct applicability -		
Conn, Ill, Ind, Ia, Me, Mass, Mich, Minn, Neb, NH, NY, ND, Ohio, Penn, RI, SD, Vt, Wis	9,503	52,739
Some modification -		
Calif, Colo, Del, Ida, Kan, Ky, Md, Mo, Mont, Nev, NJ, NC, Okla, Ore, Tenn, Utah, Va, Wash, WVa, Wy	2,073	30,087
Major changes -		
Ala, Ariz, Ark, Fla, Ga, La, Miss, NM, SC, Tex	2,023	12,051
Totals	13,599	94,877

[a] Based on a summary of lake inventory data compiled by individual states. Many inventories are incomplete, so lake numbers given are minimum values.

[b] Lakes larger than 100 surface acres.

the initial step, it is possible to gain considerable management insight and to establish priorities for data collection programs which are needed to permit the use of more scientific classification systems.

From a national point of view, it would be desirable to have a uniform classfication system that could be applied throughout the country to yield a broad-scale perspective of the condition of all the nation's lakes. This would provide a factual basis for federal lake improvement programs and would permit priorities to be established consistent with national objectives. Although several advantages could accrue from the use of a single classification system applied nationwide, it was, nevertheless, concluded that greater overall benefit would result from the implementation of workable intrastate systems. Comparisons among states and the integration of a national picture should not be ignored; steps should be taken to accommodate these goals, but they should be treated as secondary objectives, not overriding considerations. Several points contributed to this conclusion.

1) The primary benefits of lake classification relate to its use as a decision-making tool, not to a static end product. Lake condition is one variable that should be considered as part of many management decisions. Since management responsibilities are vested primarily with agencies having state or local jurisdiction, it is most important that systems with a corresponding geographical base be implemented.

2) It would be extremely difficult, if not impossible, to design a classification system that is sufficiently broad to encompass the total range of diversity found in lakes throughout the country, which, at the same time, is sufficiently detailed to separate a less diverse set of lakes within a single state. A scaled-down version of this shortcoming was noted with the classification of lakes in Wisconsin. From a statewide point of view, the classification was judged to provide a useful and meaningful perspective; however, at the county level, classifications tended to be rather uniform and, consequently, the information may be of minimal value for local decisions.

3) Some practical difficulties in the development of a nationwide classification system have been imposed by Section 314 of the 1972 Amendments to the Water Quality Act (P.L. 92-500). This act places the responsibility for lake classification on each of the individual

> states. This could expedite the use of classification for decision-making; however, it could also result in 50 different classification schemes with no common basis for comparison. This would be unfortunate and unnecessary. There is no need for that degree of specialization.

To address both state and federal needs, it would be advantageous to encourage a minimum number of classification methodologies and, at the same time, foster the development of techniques (such as remote sensing methods) for correlating the different systems to achieve a better national perspective. Systems based on subjective information can be useful initially, but these should be replaced by more sophisticated methods as data become available. Lake classification should be viewed as an iterative process which undergoes continual revision and refinement. The approach presented in this report appears to be a reasonable and practical start toward the implementation of broad-scale lake classification.

SECTION VIII

REFERENCES

Aukerman, R., and G. I. Chesley. 1971. Classifying Water Bodies: Feasibility and Recommendations for Classifying Water. Colorado State University. National Technical Information Service, Springfield, Va. Publication No. PB 208 667. 115 p.

Bjork, S. 1972. Swedish Lake Restoration Program Gets Results. Ambio 1(5):153-165.

Born, S. 1974. Inland Lake Demonstration Project. University of Wisconsin-Extension and Wisconsin Department of Natural Resources, Madison. 31 p.

Dunst, R. C., S. M. Born, P. D. Uttormark, S. A. Smith, S. A. Nichols, J. O. Peterson, D. R. Knauer, S. L. Serns, D. R. Winter, and T. L. Wirth. 1974. Survey of Lake Rehabilitation Techniques and Experiences. Wisconsin Department of Natural Resources and the University of Wisconsin, Madison. Technical Bulletin No. 75. 179 p.

Feuillade, J. 1972. Application de la Methode de l'Analyse Factorielle des Correspondances a la Classification des Lacs en Fonction de Leur Degre d'Eutrophie. Chemosphere (Pergamon Press, Great Britain) 2:95-100.

Gower, J. C. 1967. A Comparison of Some Methods of Cluster Analysis. Biometrics 23:623-637.

Gower, J. C. 1966. Some Distance Properties of Latent Root and Vector Methods Used in Multivariate Analysis. Biometrika 53:325-338.

Ketelle, M. J., and P. D. Uttormark. 1971. Problem Lakes in the United States. Water Resources Center, University of Wisconsin, Madison, and U.S. Environmental Protection Agency, Washington, D.C. Technical Report 16010 EHR 12/71. 282 p.

Lueschow, L. A., J. M. Helm, D. R. Winter, and G. W. Karl. 1970. Trophic Nature of Selected Wisconsin Lakes. Wisconsin Academy of Sciences, Arts and Letters 58:237-264.

Lopinot, A. C. 1966. Illinois Surface Water Inventory, 1965 Supplement. Illinois Department of Conservation, Division of Fisheries, Springfield. Special Fisheries Report No. 1.

McColl, R. H. S. 1972. Chemistry and Trophic Status of Seven New Zealand Lakes. New Zealand Journal of Marine and Freshwater Research 6(4):399-447.

Newton, M. E., and C. M. Fetterolf, Jr. 1966. Limnological Data from Ten Lakes, Genesee and Livingston Counties, Michigan, September 1965. Water Resources Commission, Bureau of Water Management, Michigan Department of Natural Resources, Lansing. 16 p., 40 appendices.

Peterson, S. A., W. D. Sanville, F. S. Stay, and C. F. Powers. 1974. Nutrient Inactivation as a Lake Restoration Procedure--Laboratory Investigations. U.S. Environmental Protection Agency, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon. Report No. EPA-660/3-74-032. 118 p.

Shannon, E. E., and P. L. Brezonik. 1972. Eutrophication Analysis: A Multivariate Approach. J. of Sanitary Engineering Division, ASCE 98(SA1, Proc. Paper 8735):37-57.

Sheldon, A. L. 1972. A Quantitative Approach to the Classification of Inland Waters. In: Natural Environments, Krutilla, J. V. (ed.). Johns Hopkins University Press, Baltimore, Md. p. 205-261.

Strom, K. M. 1930. Limnological Observations on Norwegian Lakes. Arch. f. Hydrobiol. 21:97-124.

U.S. Environmental Protection Agency. 1974. An Approach to a Relative Trophic Index System for Classifying Lakes and Reservoirs. National Eutrophication Survey, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon. Working Paper No. 24. 36 p.

Vollenweider, R. A. In press. Input-Output Models. Canada Centre for Inland Waters, Burlington, Ontario. 48 p.

Vollenweider, R. A. 1968. Scientific Fundamentals of the Eutrophication of Lakes and Flowing Waters, with Particular Reference to Nitrogen and Phosphorus as Factors in Eutrophication. Organisation for Economic Co-operation and Development, Directorate of Scientific Affairs, Paris, France. Report No. DAS/CSI/68.27. 159 p., and appendices.

Wall, J. P., M. J. Ketelle, and P. D. Uttormark. 1973. Wisconsin Lakes Receiving Sewage Effluents. Water Resources Center, University of Wisconsin, Madison. Technical Report No. 73-1.

Wisconsin Department of Natural Resources. 1968. Wisconsin Outdoor Recreation Plan. Madison. Publication No. 802. 397 p.

Zafar, A. R. 1959. Taxonomy of Lakes. Hydrobiologia 13: 287-299.

SECTION IX

APPENDICES

Page

Classification of Wisconsin Lakes. 82

Notes Regarding State Lake Inventories . . 174

Lake Inventory Questionnaire 177

APPENDIX I

CLASSIFICATION OF WISCONSIN LAKES

The following information is included in the appendix:

- County Number
- County Name
- Lake Number (LKNO) as assigned by Dept. of Natural Resources
- Lake Name
- Area (surface area in acres)
- Maximum Depth (MXD) in feet
- Inlet - Presence/absence denoted by "yes" or "no" answer.
- Outlet -
- Type of Lake:
  - Natural (NAT)
  - Natural Lake with Level Control (NLLC)
  - Impoundment (IMP)
- Breakdown of Lake Classification scores:
  - D.O. = number of penalty points received for hypolimnetic dissolved oxygen conditions
  - TRNS = number of penalty points received for water transparency (Secchi disk measurements)
  - FSKL = number of penalty points received for history of fishkills
  - IMPR = number of penalty points received for impairment of lake-use due to nuisance algal blooms or excess rooted aquatic plants
  - LCI = Lake Condition Index: the lake's score achieved with the classification system (The score is a total of the points received for D.O., TRNS, FSKL, and IMPR.)

There are 1149 lakes listed in the appendix, and Lake Condition Index (LCI) scores are presented for 1147 of these. LCI values could not be calculated for the remaining 2 because of insufficient data.

Of the 1147 scores listed, 18 are marked with an asterisk because some facet of the data input appeared questionable. Therefore, the values for these 18 should be regarded as probable.

Because the Wisconsin Department of Natural Resources maintains an active lake mapping program, certain measurements, such as surface area and depth, will be subject to periodic change. Generally, such changes will be minor (less than 1% overall), but this point should be kept in mind by the reader.

Notes for NLI Data Appendix:

The Wisconsin lakes which comprised the subject matter of this study are listed alphabetically by county in the following appendix. There are 72 counties (including Menominee) in the state; 61 have lakes with surface areas of 100 acres or greater. The counties, with the number of project lakes in each, are listed below.

County number	County name	Number of lakes	County number	County name	Number of lakes
1	Adams	6	37	Marathon	8
2	Ashland	17	38	Marinette	20
3	Barron	31	39	Marquette	7
4	Bayfield	41	40	Menominee	6
5	Brown	0	41	Milwaukee	0
6	Buffalo	0	42	Monroe	9
7	Burnett	71	43	Oconto	30
8	Calumet	0*	44	Oneida	136
9	Chippewa	13	45	Outagamie	0
10	Clark	4	46	Ozaukee	1
11	Columbia	5	47	Pepin	0
12	Crawford	0	48	Pierce	0
13	Dane	12	49	Polk	42
14	Dodge	7	50	Portage	5
15	Door	5	51	Price	33
16	Douglas	21	52	Racine	9
17	Dunn	3	53	Richland	2
18	Eau Claire	4	54	Rock	0**
19	Florence	16	55	Rusk	17
20	Fond du Lac	4	56	St. Croix	8
21	Forest	35	57	Sauk	4
22	Grant	5	58	Sawyer	58
23	Green	2	59	Shawano	10
24	Green Lake	5	60	Sheboygan	5
25	Iowa	2	61	Taylor	4
26	Iron	32	62	Trempealeau	1
27	Jackson	7	63	Vernon	0
28	Jefferson	9	64	Vilas	173
29	Juneau	13	65	Walworth	19
30	Kenosha	8	66	Washburn	55
31	Kewaunee	0	67	Washington	7
32	La Crosse	1	68	Waukesha	22
33	Lafayette	1	69	Waupaca	13
34	Langlade	15	70	Waushara	12
35	Lincoln	19	71	Winnebago	6
36	Manitowoc	4	72	Wood	9

*Lake Winnebago is listed under Winnebago County.

**Lake Koshkonong is listed under Jefferson County.

COUNTY #1 - ADAMS

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Big Roche-a-Cri	122	20	Yes	Yes	IMP	3	1	0	2	6
9	Friendship	115	16	Yes	Yes	IMP	3	2	0	3	8
11	Jordan	213	79	No	No	NAT	4	1	0	0	5
12	Mason	857	10	Yes	Yes	IMP	3	2	0	2	7
47	Sherwood	250	30	Yes	Yes	IMP	3	2	0	2	7
48	Camelot	415	30	Yes	Yes	IMP	3	2	0	2	7

COUNTY #2 - ASHLAND

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Augustine	166	10	No	No	NAT	1	2	0	0	3
2	Bad River	185	7	No	Yes	NAT	0	2	0	0	2
5	Bear	220	8	Yes	Yes	NAT	0	2	0	0	2
9	Beaver Dam	118	19	Yes	Yes	NLLC	1	2	0	0	3
14	Caroline	130	8	Yes	Yes	NLLC	3	2	3	0	8
23	East Twin	110	15	Yes	Yes	NAT	1	2	0	0	3
24	English	244	40	Yes	Yes	NAT	2	2	0	0	4
26	Galillee	212	23	Yes	Yes	NAT	1	2	0	2	5
29	Gordon	142	28	Yes	Yes	NLLC	1	2	0	0	3
33	Kakagon	766	26	Yes	Yes	NAT	1	2	0	0	3
39	Little Clam	144	11	No	No	NAT	1	2	0	2	5
41	Long	111	15	No	Yes	NAT	3	2	3	0	8
46	Meder	135	10	Yes	Yes	NAT	3	2	0	0	5
48	Mineral	225	29	Yes	Yes	NAT	1	2	0	0	3
62	Spider	103	20	Yes	Yes	NAT	1	2	0	2	5
71	Upper Clam	165	20	Yes	Yes	NLLC	1	2	0	0	3
153	Madeline Island	105	10		Yes	NAT	3	2	3	2	10

COUNTY #3 - BARRON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
8	Bass	118	14	No	No	NAT	0	1	0	0	1
11	Bear	1358	87	Yes	Yes	NLLC	0	1	0	2	3
12	Beaver Dam	1112	106	No	Yes	NLLC	0	4	0	2	6
13	Big Dummy	135	58	No	No	NAT	2	3	0	0	5
14	Big Moon	191	48	Yes	Yes	NAT	0	1	0	2	3
19	Butternut	141	15	No	No	NAT	3	2	0	2	7
21	Chain	107	19	No	No	NAT	3	2	0	0	5
34	Duck	100	26	Yes	Yes	NAT	1	2	0	0	3
35	Echo	161	41	No	No	NAT	2	2	0	2	6
40	Granite	154	34	Yes	Yes	NAT	2	2	0	0	4
42	Hemlock	357	21	Yes	Yes	NLLC	1	2	0	2	5
44	Horseshoe	115	19	No	No	NAT	3	2	0	0	5
50	Lake Chetek	770	22	Yes	Yes	NLLC	0	2	0	9	11
59	Little Sand	101	36	No	No	NLLC	2	2	0	0	4
64	Lower Devil's	162	26	No	No	NAT	3	1	3	0	7
66	Lower Turtle	276	24	Yes	Yes		3	2	0	0	5
70	Montanis	200	14	Yes	Yes	NAT	0	2	0	2	4
77	Mud	578	15	Yes	Yes	IMP	0	2	0	4	6
84	Pokegama	506	19	Yes	Yes	IMP	1	2	0	7	10
85	Poskin	150	30	Yes	Yes	NLLC	1	2	0	4	7
87	Prairie	1534	16	Yes	Yes	IMP	1	2	0	7	10

COUNTY #3 - BARRON Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
88	Red Cedar	1841	53	Yes	Yes	NLLC	0	2	0	0	2
89	Rice	939	19	Yes	Yes	IMP	3	1	0	2	6
93	Sand	322	57	Yes	Yes	NLLC	2	1	0	2	5
95	Silver	337	91	No	No	NAT	0	2	0	0	2
99	Staples	305	17	Yes	Yes	NAT	0	2	3	9	14
100	Stump	129	7	Yes	Yes	IMP	5	2	3	6	16
103	Tenmile	376	12	Yes	Yes	IMP	0	2	0	9	11
104	Tuscobta	157	27	Yes	Yes	NLLC	3	2	0	6	11
107	Upper Turtle	440	25	Yes	Yes	NAT	3	2	0	2	7
109	Vermillion	208	55	Yes	Yes	NAT	2	2	0	0	4

COUNTY #4 - BAYFIELD

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
8	Atkins	190	81	Yes	Yes	NAT	0	1	0	0	1
11	Bark Bay	116	8	Yes	Yes	NAT	1	2	0	0	3
20	Basswood	119	9	No	Yes	NAT	3	2	0	2	7
31	Birch	129	8	Yes	Yes	NAT	0	2	0	0	2
38	Bony	200	52	No	Yes	NAT	0	1	0	0	1
41	Buffalo	190	25	No	No	NAT	1	1	0	0	2
46	Buskey Bay	100	51	Yes	Yes	NAT	0	1	0	0	1
47	Cable	166	44	Yes	Yes	NAT	2	1	0	0	3
60	Chippewa	319	11	No	Yes	NAT	1	2	3	0	6
68	Cranberry	131	12	No	Yes	NAT	1	2	3	0	6
72	Crystal	122	30	No	Yes	NAT	1	1	0	0	2
78	Deep	125	29	No	No	NAT	1	1	0	0	2
80	Dells	103	42	No	No	NAT	2	2	0	0	4
81	Delta	180	30	Yes	Yes	NAT	0	1	0	0	1
83	Diamond	331	83	Yes	Yes	NAT	0	2	0	0	2
85	Drummond	130	44	Yes	Yes	NLLC	2	1	0	2	5
90	Eagle	159	55	Yes	Yes	NAT	2	1	0	0	3
96	Ellison	110	18	No	No	NAT	1	1	0	0	2
114	Ghost	142	30	No	Yes	NAT	1	2	0	0	3
116	Half Moon	106	10	No	No	NAT	1	2	3	0	6
119	Hart	259	54	Yes	Yes	NAT	4	1	0	0	5

COUNTY #4 - BAYFIELD Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
141	Iron	248	13	Yes	Yes	NAT	3	2	3	0	8
146	Jackson	142	13	Yes	Yes	NAT	1	2	0	2	5
169	Long	263	23	No	No	NAT	1	2	0	2	5
179	Middle Eau Claire	902	66	Yes	Yes	NLLC	2	0	0	2	4
180	Millicent	184	56	Yes	Yes	NAT	2	0	0	0	2
188	Mud	178	10	No	No		3	2	3	2	10
196	Namekagon	3208	46	Yes	Yes	NLLC	2	2	0	2	6
205	Oriental	144	32	Yes	Yes	IMP	2	3	0	0	5
208	Owen	1323	95	No	Yes	NLLC	2	0	0	0	2
219	Pigeon	213	21	No	No	NAT	1	1	0	0	2
250	Sand Bar	114	51	No	No	NAT	0	1	0	0	1
259	Siskiwit	330	13	Yes	Yes	NAT	1	2	0	0	3
266	Spider	124	20	No	Yes	NAT	1	3	0	0	4
272	Star	201	52	No	Yes	NAT	0	1	0	0	1
278	Tahkodah	152	18	No	No	NAT	1	2	0	0	3
284	Tomahawk	134	42	No	No	NAT	0	2	0	0	2
287	Totagatic	537	8	Yes	Yes	NAT	3	2	0	0	5
302	Twin Bear	160	59	Yes	Yes	NAT	0	1	0	0	1
304	Upper Eau Claire	1030	84	Yes	Yes	NLLC	2	0	0	0	2
312	White Bass	116	30	No	Yes	NAT	1	1	0	0	2

COUNTY #7 - BURNETT

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
8	Bashaw	171	15	Yes	Yes	NAT	0	2	0	3	5
10	Bass	110	18	No	No	NAT	5	2	3	0	10
13	Bass	226	24	No	No	NAT	1	2	0	0	3
15	Bass	207	6	No	No	NAT	5	2	3	2	12
20	Benoit	279	40	No	Yes	NAT	2	2	0	2	6
23	Big Bear	189	17	No	No	NAT	1	1	0	0	2
24	Big Doctor	222	6	No	No	NAT	5	2	3	2	12
25	Big McKenzie	1142	71	Yes	Yes	NAT	0	0	0	0	0
26	Big Sand	1400	55	No	No	NAT	0	1	0	2	3
27	Birch Island	838	13	No	No	NAT	5	1	3	2	11
39	Cadotte	127	18		Yes	NLLC	1	1	0	2	4
41	Clam River	359	29	Yes	Yes	IMP	1	2	0	0	3
43	Clear	115	55	No	No	NAT	0	2	0	0	2
45	Conners	109	13	No	No	NAT	1	2	0	2	5
51	Crooked	180	10	No	No	NAT	5	2	3	2	12
52	Crooked	247	13	No	No	NAT	5	3	3	2	13
56	Danbury	256	10	Yes	Yes	IMP	1	2	0	3	6
58	Deer	157	18	No	No	NAT	3	2	0	2	7
59	Des Moines	229	37			NAT	2	2	0	0	4
60	Devils	1001	24	No	No	NAT	1	2	0	2	5
64	Dunham	243	63	Yes	Yes	NAT	2	1	0	0	3

COUNTY #7 - BURNETT Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
69	Elbow	248	8	No	No	NAT	5	2	3	2	12
75	Fish	356	29	No	No	NAT	0	1	0	2	3
79	Gaslyn	164	12	No	Yes	NAT	5	2	3	2	12
83	Green	279	5	No	No	NAT	5	2	3	2	12
85	Gull	197	18	Yes	Yes	NAT	1	2	0	0	3
86	Ham	324	29	No	No	NAT	1	0	0	2	3
87	Hanscom	127	7	No	No	NAT	5	2	3	2	12
94	Johnson	397	23	No	No	NAT	5	2	3	2	12
102	Lily	176	18	No	No	NAT	3	4	3	0	10
105	Lipsett	393	24	Yes	Yes	NAT	3	2	0	2	7
108	Little Bear	128	54	No	No	NAT	4	1	0	0	5
114	Little Long	100	23	No	No	NAT	1	2	0	0	3
115	Little Wood	207	23	Yes	Yes	NAT	1	2	0	2	5
116	Little Yellow	285	19	Yes	Yes	NAT	1	2	0	2	5
118	Long	318	13	Yes	Yes	NAT	1	2	0	2	5
119	Long	251	41	No	No	NAT	2	1	0	0	3
121	Loon	189	24	Yes	Yes	NLLC	1	2	0	0	3
125	Lost Lakes	248	4	Yes	Yes	NLLC	5	2	3	0	10
126	Love	253	63	No	Yes	NLLC	0	1	0	0	1
127	Lower Clam	337	14	Yes	Yes	NLLC	1	2	0	3	6

COUNTY #7 - BURNETT Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
128	Lower Twin	123	9	No	No	NAT	5	2	3	2	12
130	Mallard	113	35	No	No	NAT	0	1	0	0	1
132	McGraw	135	25	Yes	Yes	NAT	3	2	0	0	5
135	Middle McKenzie	530	45	Yes	Yes	NAT	4	2	0	0	6
137	Minerva	222	22	Yes	Yes	NLLC	1	2	0	0	3
143	Mud	163	3	No	No	NAT	5	2	3	0	10
145	Mud Hen	563	66	Yes	Yes	NAT	0	1	0	0	1
146	Myre	128	20	No	No	NAT	1	2	0	0	3
149	Nicaboyne	291	34	No	No	NAT	4	1	0	2	7
153	Oak	227	19	No	No	NAT	3	0	0	0	3
155	Owl	127	27	No	No	NAT	1	2	0	0	3
165	Point	144	7	No	No	NAT	5	2	3	0	10
166	Pokegama	223	56	Yes	Yes	NLLC	4	2	0	0	6
172	Rice	311	10	No	No	NAT	1	2	0	2	5
176	Rooney	322	30	No	No	NAT	3	1	0	0	4
177	Round	204	27	Yes	Yes	NAT	3	2	3	7	15
182	Sand	962	73	No	No	NAT	0	0	0	0	0
183	Shoal	247	4	No	No	NAT	5	2	3	2	12
188	Spencer	188	19	No	No	NAT	5	2	3	2	12
189	Spirit	593	27	Yes	Yes	NLLC	3	2	0	2	7
197	Tabor	163	25	No	Yes	NAT	3	2	0	2	7

COUNTY #7 - BURNETT Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
204	Trade	426	39	Yes	Yes	NAT	4	4	0	2	10
206	Twenty-Six	230	45	Yes	Yes	NAT	0	0	0	0	0
208	Upper Clam	1207	11	Yes	Yes	NLLC	1	2	0	3	6
209	Upper Twin	163	17	No	No	NAT	5	2	3	2	12
210	Viola	262	33	No	No	NAT	2	1	0	0	3
211	Warner	176	75	No	Yes	NAT	0	2	0	0	2
212	Webb	759	27	Yes	Yes	NAT	3	2	0	0	5
214	Wood	521	35	Yes	Yes	NAT	4	2	0	2	8
215	Yellow	2287	32	Yes	Yes	NAT	2	2	0	2	6

COUNTY #9 - CHIPPEWA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
35	Chain	510	78	Yes	Yes	NAT	4	0	0	0	4
38	Chippewa Falls Flow	282	29	Yes	Yes	IMP	3	2	3	0	8
40	Cornell Flowage	577	54	Yes	Yes	IMP	2	2	0	0	4
41	Cornell	194	39		Yes	IMP	4	2	0	2	8
71	Holcombe Flowage	3890	61	Yes	Yes	IMP	2	2	0	0	4
85	Lake Wissota	5588	72	Yes	Yes	IMP	2	2	0	2	6
98	Long	1060	96	Yes	Yes	NAT	2	1	0	0	3
99	Loon	125	5	No	No	NAT	5	2	3	0	10
102	Marsh Miller	436	14	Yes	Yes	NLLC	0	2	0	3	5
123	Old Abe	646	36	Yes	Yes	IMP	2	2	0	0	4
134	Pike	173	32	No	Yes	NAT	2	2	0	2	6
135	Pine	262	115	No	Yes	NAT	2	0	0	0	2
152	Round	216	18	No	Yes	NAT	3	2	0	2	7

COUNTY #10 - CLARK

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Arbutus	821	56	Yes	Yes	IMP	4	2	0	2	8
3	Rock Dam	118	10	Yes	Yes	IMP	3	2	0	4	9
4	Mead	320	16	Yes	Yes	IMP	3	2	0	2	7
5	Sherwood	117	9	Yes	Yes	IMP	5	2	0	2	9

COUNTY #11 - COLUMBIA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
9	Lazy	174	8	Yes	Yes	IMP	5	3	3	6	17
13	Park	219	27	Yes	Yes	IMP	5	2	3	9	19
17	Swan	419	82	Yes	Yes	NAT	2	2	0	2	6
21	Wisconsin	9000	24	Yes	Yes	IMP	5	3	3	5	16
50	French Creek	655	5	Yes		IMP	3	3	0	2	8

COUNTY #13 - DANE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Cherokee	335	5	Yes	Yes	NAT	3	3	0	2	8
5	Crystal	571	9	Yes	Yes	NAT	5	3	3	3	14
6	Fish	252	62	Yes	Yes	NAT	2	1	0	3	6
10	Kegonsa	2716	31	Yes	Yes	NLLC	4	3	4	9	20
11	Marshall	194	5	Yes	Yes	IMP	3	3	0	9	15
13	Mendota	9730	82	Yes	Yes	NLLC	2	2	4	9	17
14	Monona	3335	64	Yes	Yes	NAT	2	1	4	9	16
16	Mud-Lower	195	15	Yes	Yes	NAT	1	3	0	5	9
17	Mud-Upper	223	8	Yes	Yes	NAT	3	3	3	9	18
19	Rockdale	104	5	Yes	Yes	IMP	3	3	3	4	13
25	Waubesa	2113	34	Yes	Yes	NLLC	2	3	4	9	18
27	Wingra	345	21	Yes	Yes	NLLC	1	3	0	5	9

COUNTY #14 - DODGE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Beaver Dam	5540	8	Yes	Yes	IMP	3	3	3	7	16
3	Chub	120	2	Yes	Yes	NAT	5	4	3	2	14
7	Emily	268	12	Yes	Yes	NLLC	3	3	3	9	18
8	Fox	2120	19	Yes	Yes	IMP	3	3	3	9	18
11	Lost Lake	256	5	Yes	Yes	NAT	5	3	3	7	18
16	Neosho	146	6	Yes	Yes	IMP	3	3	3	7	16
17	Sinnissippi	2300	5	Yes	Yes	IMP	5	4	3	2	14

COUNTY #15 - DOOR

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Clark	778	22	Yes	Yes	NLLC	1	1	0	0	2
6	Europe	290	8	No	No	NAT	1	2	0	0	3
10	Kangaroo	1099	13	Yes	Yes	NLLC	1	2	0	0	3
15	MacKaysee	324	26	No	No	NAT	1	1	0	0	2
17	Mud	155	5	Yes	Yes	NAT	5	2	3	2	12

COUNTY #16 - DOUGLAS

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Amnicon	426	31	Yes	Yes	NAT	2	2	0	2	6
5	Bardon	832	102	No	No	NAT	0	1	0	0	1
6	Bass	126	26	Yes	Yes	NAT	1	2	0	0	3
21	Bond	292	64	No	No	NAT	0	1	0	0	1
34	Cranberry	172	19	Yes	Yes	NAT	1	2	0	0	3
40	Crystal	293	21	No	No	NAT	0	1	0	0	1
45	Dowling	154	13	Yes	No	NAT	1	2	0	0	3
66	Leader	165	56	No	No	NAT	0	1	0	0	1
74	Loon	109	20	No	No	NAT	5	2	3	0	10
75	Lower Eau Claire	792	41	Yes	Yes	NLLC	2	1	0	0	3
80	Lyman	403	15	Yes	Yes	NLLC	1	2	0	2	5
85	Minnesuing	432	43	Yes	Yes	NAT	2	2	0	0	4
98	Nebagamon	914	56	Yes	Yes	NAT	0	1	0	0	1
104	Person	172	10	No	No	NAT	5	2	0	2	9
112	Red	252	39	No	No	NAT	2	1	0	0	3
118	St. Croix	1913	28	Yes	Yes	IMP	1	2	0	3	6
121	Sauntry	110	9	No	No	NAT	5	2	0	0	7
127	Simms	152	41	No	No	NAT	2	1	0	0	3
133	Steele	157	8	Yes	No	NAT	3	2	0	2	7
141	Twin	113	5	No	No	NAT	5	2	0	0	7
147	Upper St. Croix	855	22	Yes	Yes	NAT	1	2	0	0	3

COUNTY #17 - DUNN

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
10	Eau Galle	351	18	Yes	Yes	IMP	1	2	0	0	3
11	Menomin	1405	34	Yes	Yes	IMP	0	2	0	2	4
18	Tainter	1752	37	Yes	Yes	IMP	4	2	0	7	13

COUNTY #18 - EAU CLAIRE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Altoona	840	25	Yes	Yes	IMP	1	2	3	4	10
4	Dells Pond	739	30	Yes	Yes	IMP	1	2	0	2	5
5	Eau Claire	1118	25	Yes	Yes	IMP	1	3	0	7	11
8	Halfmoon	132	9	Yes	Yes	NAT	5	2	0	7	14

COUNTY #19 - FLORENCE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Bass	102	68	Yes	Yes	NAT	4	0	0	0	4
19	Elwood	135	25	No	No	NAT	3	0	0	0	3
20	Emily	197	43	Yes	Yes	NAT	2	0	0	0	2
21	Fay	247	13	Yes	Yes	NAT	3	2	0	2	7
30	Halsey	512	10	Yes	Yes	NAT	3	2	0	2	7
37	Keyes	202	77	Yes	No	NAT	2	0	0	0	2
44	Long	340	23	Yes	Yes	NLLC	5	2	3	2	12
66	Patten	256	52	Yes	Yes	NAT	4	2	0	0	6
71	Price	107	8	Yes	No	NAT	3	2	3	2	10
77	Savage	150	10	Yes	No	NAT	3	2	3	0	8
79	Sealion	122	82	Yes	Yes	NAT	4	1	0	2	7
82	Shadow	109	30	Yes	No	NAT	3	1	0	0	4
10	Brule River	197	70	Yes	Yes	IMP	4	2	0	0	6
39	Kingsford	415	33	Yes	Yes	IMP	4	2	0	0	6
69	Pine River	145	38	Yes	Yes	IMP	4	2	0	0	6
89	Twin Falls	682	15	Yes	Yes	IMP	3	2	0	0	5

COUNTY #20 - FOND DU LAC

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Aubvrn	107	29	Yes	Yes	NAT	3	1	0	2	6
12	Kettle Morraine	240	30	Yes	Yes	NAT	5	2	3	3	13
13	Long	409	47	Yes	Yes	NLLC	4	1	0	2	7
19	Mullet	200	7	Yes	Yes	NAT	5	2	3	3	13

COUNTY #21 - FOREST

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Arbutus	161	35	No	No	NAT	4	2	0	0	6
2	Atkins	151	4	No	Yes	NAT	5	2	0	0	7
8	Birch	468	72	No	Yes	NAT	4	2	0	0	6
9	Bishop	288	12	Yes	Yes	NLLC	3	2	0	5	10
13	Bog Brook	490	6	Yes	Yes	IMP	5	2	0	0	7
20	Butternut	1292	42	No	Yes	NAT	4	0	0	0	4
32	Crane	337	26	No	Yes	NAT	3	2	0	0	5
52	Franklin	892	53	No	Yes	NAT	4	0	0	0	4
64	Hay Meadow	241	9	Yes	Yes	IMP	5	2	3	0	10
65	Hiles	713	5	Yes	Yes	IMP	5	2	3	2	12
66	Himley	149	8	No	Yes	NAT	3	2	0	0	5
69	Howell	177	15	No	Yes	NAT	3	2	0	0	5
75	Julia	401	47	Yes	Yes	NAT	4	2	0	0	6
76	Jungle	182	12	Yes	Yes	NAT	3	2	0	0	5
84	Laura	110	21	No	No	NAT	3	2	0	0	5
85	Lily	212	25	Yes	Yes	NLLC	3	2	0	0	5
90	Little Long	102	28	No	No	NAT	3	0	0	0	3
94	Little Rice	1219	10	Yes	Yes	IMP	5	2	3	2	12
96	Little Sand	248	21	No	No	NAT	3	0	0	0	3
104	Lucerne	1026	68	No	Yes	NAT	2	0	0	0	2

COUNTY #21 - FOREST Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
114	Metonga	2157	74	Yes	Yes	NLLC	2	0	0	0	2
128	Pat Shay	120	5	No	Yes	NAT	5	2	0	2	9
130	Peshtigo	156	4	Yes	Yes	NAT	5	4	0	7	16
131	Pickerel	1299	14	Yes	Yes	NLLC	5	2	0	5	12
133	Pine	1670	14	Yes	Yes	NLLC	5	2	3	2	12
142	Rice	208	6	Yes	Yes	NAT	5	2	0	0	7
144	Riley	213	12	Yes	Yes	NAT	3	2	0	0	5
147	Roberts	452	32	Yes	Yes	NAT	4	2	0	2	8
168	St. Johns	104	21	No	No	NAT	3	0	0	0	3
152	Scattered Rice	486	10	Yes	Yes	IMP	3	2	0	2	7
159	Shoe	168	7		Yes		5	2	3	0	10
160	Silver	334	20	Yes	Yes	NAT	3	0	0	0	3
167	Stevens	295	10	Yes	Yes	NAT	3	2	0	0	5
175	Trump	172	20	No	Yes	NAT	5	2	0	2	9
179	Wabicon	594	15	No	Yes	NAT	3	2	0	2	7

COUNTY #22 - GRANT

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Bertom Lake	126	8	Yes	Yes		5	3	3	2	13
5	Cassville Slough	674	30	Yes	Yes		2	3	0	2	7
16	Jack Oak Slough	145	16	Yes	Yes		1	3	0	2	6
20	McCartney Lake	924	10	Yes	Yes		5	3	3	2	13
29	State Line Slough	310	30	Yes	Yes		2	3	0	2	7

COUNTY #23 - GREEN

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Albany	102	8	Yes	Yes	IMP	1	3	0	5	9
2	Decatur	151	10	Yes	Yes	IMP	3	3	0	5	11

COUNTY #24 - GREEN LAKE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Grand	234	7	Yes	Yes	IMP		3	0	2	
3	Green	7325	229	Yes	Yes	NAT	2	0	0	2	4
4	Little Green	465	24	Yes	Yes	NAT	3	1	3	5	12
7	Maria	596	6	No	No	NAT	5	2	3	2	12
8	Puckaway	5433	5	Yes	Yes	NLLC	1	3	0	3	7

COUNTY #25 - IOWA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
10	Twin Valley	145	36	Yes	Yes	IMP	6	1	0	5	12
15	Blackhawk	220	40	Yes	Yes	IMP	4	1	0	2	7

COUNTY #26 - IRON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
13	Big Pine	632	22	Yes	Yes	NAT	3	2	0	2	7
17	Boot	180	16	No	No	NAT	3	2	0	2	7
23	Catherine	118	11	Yes	Yes	NAT	3	2	0	2	7
24	Cedar	193	21	Yes	Yes	NAT	3	2	0	0	5
47	Echo	220	25	Yes	Yes	NAT	3	2	0	0	5
57	Fisher	452	25	Yes	Yes	NLLC	3	2	0	2	7
58	Flambeau	13545	50	Yes	Yes	IMP	4	2	0	0	6
64	Gile	3384	25	Yes	Yes	IMP	3	2	0	0	5
66	Grand Portage	144	31	Yes	Yes	NAT	4	2	0	2	8
67	Grant	107	10	Yes	Yes	NAT	3	2	0	2	7
80	Island	352	17	Yes	Yes	NAT	3	2	0	0	5
95	Lake of the Falls	338	23	Yes	Yes	NLLC	3	2	0	0	5
96	Lake Six	147	11	No	No	NAT	5	2	3	0	10
109	Little Pike	100	19	Yes	No	NAT	5	2	3	2	12
111	Long	373	30	Yes	Yes	NAT	3	2	0	2	7
117	Martha	146	55	Yes	Yes	NAT	4	2	0	0	6
122	Mercer	184	24	Yes	Yes	NAT	3	2	0	2	7
125	Moose	269	12	Yes	Yes	NAT	3	2	0	0	5
135	North Bass	180	9	No	No	NAT	3	2	0	0	5
149	Owl	126	38	No	No	NAT	4	2	0	2	8
151	Pardee	206	27	Yes	Yes	NAT	3	2	0	0	5

COUNTY #26 - IRON Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
154	Pike	194	80	Yes	Yes	NAT	4	2	0	0	6
155	Pine	312	34	Yes	Yes	NAT	4	2	0	0	6
160	Randall	115	10	Yes	Yes	NAT	3	2	0	0	5
163	Rice	125	20	Yes	Yes	NAT	3	2	0	2	7
168	Sand	101	35	Yes	No	NAT	4	0	0	0	4
170	Sandy Beach	112	7	Yes	No	NAT	3	2	0	2	7
184	Spider	361	41	Yes	Yes	NAT	4	2	0	0	6
197	Trude	754	48	Yes	No	NAT	4	2	0	2	8
199	Upper Springstead	126	23	Yes	Yes	NAT	3	2	0	0	5
203	Virgin	119	45	Yes	Yes	NAT	4	2	0	0	6
211	Wilson	155	21	Yes	No	NAT	3	2	0	0	5

COUNTY #27 - JACKSON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
14	Potter	348	24	Yes	Yes	IMP	5	2	0	0	7
16	Seventeen	178	4	Yes	Yes	IMP	5	2	3	0	10
34	Black River	198	34	Yes	Yes	IMP	2	2	0	2	6
42	13/8	110	4	Yes	Yes	IMP	3	4	0	3	10
60	31/2	182	5	Yes	Yes	IMP	3	2	0	0	5
61	31/5	110	7	Yes	Yes	IMP	3	2	0	0	5
110	16/14	170	7	Yes	Yes	IMP	2	2	0	6	10

COUNTY #28 - JEFFERSON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Blue Spring	136	12	Yes	Yes	NLLC	1	2	0	5	8
5	Goose	144	4	Yes	Yes	NAT	5	3	3	5	16
9	Hope	142	24	No	Yes	NAT	5	1	3	5	14
10	Koshkonong	10480	6	Yes	Yes	NLLC	5	4	3	2	14
12	Spring-Lower	106	14	Yes	Yes	IMP	3	3	0	5	11
15	Red Cedar	370	6	No		NAT	5	3	3	9	20
16	Ripley	433	50	Yes	Yes	NAT	2	2	0	5	9
17	Rock	1371	56	Yes	Yes	NLLC	2	2	0	5	9
18	Rome	477	12	Yes	Yes	IMP	5	3	3	9	20

COUNTY #29 - JUNEAU

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Castle Rock Flowage	16440	36	Yes	Yes	IMP	6	3	4	2	15
3	Meadow Valley	1190	8	Yes	Yes	IMP	5	3	3	2	13
4	Petenwell	22218	44	Yes	Yes	IMP	6	3	4	2	15
5	Potters	299	15	Yes	Yes	IMP	3	3	3	2	11
6	Rynearson	570	14	Yes	Yes	IMP	5	3	3	2	13
7	Rynearson	493	10	Yes	Yes	IMP	5	3	3	2	13
8	Sprague	1930	9	Yes	Yes	IMP	5	3	3	2	13
16	8/8	249	4	No	Yes	IMP	5	3	3	2	13
23	19/8	180	8	Yes	Yes	IMP	5	3	3	2	13
37	19/9	136	8	Yes	Yes	IMP	5	3	3	2	13
44	12/15	125	15	Yes	Yes	IMP	3	3	0	2	8
48	33/15	1868	35	Yes	Yes	IMP	4	3	0	2	9
50	13/13	300	13	Yes	Yes	IMP	3	3	0	2	8

COUNTY #30 - KENOSHA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Benet and Shangrila	154	24	Yes	Yes	NLLC	5	2	3	3	13
4	Camp	482	17	Yes	Yes	NLLC	5	2	3	4	14
5	Center	106	30	Yes	Yes	NLLC	3	1	0	2	6
8	Elizabeth	622	30	Yes	Yes	NLLC	3	1	0	2	6
15	Marie	297	38	Yes	Yes	NLLC	4	2	0	2	8
19	Paddock	112	32	Yes	Yes	NLLC	4	2	0	3	9
21	Powers	418	34	Yes	Yes	NLLC	4	2	0	2	8
23	Silver	499	43	Yes	Yes	NLLC	4	2	0	2	8

COUNTY #32 - LA CROSSE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Neshonoc	687	11	Yes	Yes	IMP	3	2	0	0	5

COUNTY #33 - LAFAYETTE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Yellowstone	455	21	Yes	Yes	IMP	3	3	3	9	18

COUNTY #34 - LANGLADE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
15	Black Oak	59	32	Yes	Yes	NAT	4	2	0	0	6
29	Duck	125	19	No	No	NAT	3	2	0	0	5
31	Dynamite	97	22	Yes	Yes	NAT	3	2	0	0	5
40	Enterprise	502	28	Yes	Yes	NAT	3	2	0	0	5
56	Greater Bass	270	28	Yes	Yes	NAT	3	2	0	0	5
117	Mary	156	9	Yes	Yes	NAT	3	2	0	0	5
127	Moccasin	110	38	No	No	NAT	4	2	0	0	6
129	Moose	105	20	Yes	Yes	NAT	3	0	0	0	3
111	Post, Lower	377	8	Yes	Yes	IMP	3	2	0	2	7
216	Post, Upper	758	14	Yes	Yes	IMP	3	2	0	2	7
170	Rolling Stone	688	12	Yes	Yes	NLLC	3	2	0	2	7
171	Rose	109	24	No	Yes	NAT	3	1	0	0	4
176	Sawyer	169	30	Yes	No	NAT	3	0	0	0	3
196	Summit	282	26	Yes	Yes	NLLC	3	2	0	0	5
224	White	166	44	No	Yes	NLLC	4	0	0	0	4

COUNTY #35 - LINCOLN

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Alexander	750	36	Yes	Yes	IMP	4	2	0	2	8
4	Alice	1491	32	Yes	Yes	IMP	4	1	0	0	5
20	Bridge	444	17	Yes	Yes	NLLC	3	2	0	2	7
33	Clear	295	45	No	Yes	NAT	4	2	0	2	8
37	Crystal	104	22	No	No	NAT	3	0	0	0	3
38	Deer	137	62	No	Yes	NLLC	4	0	0	0	4
54	Grandfather	223	32	Yes	Yes	IMP	4	2	0	0	6
55	Grandmother	199	22	Yes	Yes	IMP	3	2	0	0	5
71	Jersey City	349	17	Yes	Yes	IMP	3	2	0	2	7
85	Long	132	64	No	Yes	NAT	4	0	0	0	4
98	Mohawksin	1898	26	Yes	Yes	IMP	3	2	0	2	7
102	Muskellunge	159	23	No	Yes	NAT	3	1	0	0	4
110	Pesobic	146	11	No	Yes	NAT	3	2	3	2	10
115	Pine	145	15	No	No	NAT	1	2	0	2	5
122	Seven Island	136	33	No	No	NAT	4	1	0	0	5
128	Somo, Big	345	25	Yes	Yes	NAT	3	2	0	0	5
130	Spirit River	1239	22	Yes	Yes	IMP	3	2	0	0	5
142	Tug	154	21	Yes	Yes	NLLC	3	2	0	0	5
144	Ward	108	13	Yes	Yes	IMP	3	2	0	2	7

COUNTY #36 - MANITOWOC

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Cedar	139	26	No	No	NAT	3	1	0	2	6
22	Long	120	37	No	No	NAT	4	1	0	4	9
33	Rockville	137	7	Yes	Yes	IMP	5	3	0	0	8
46	Wilke	107	22	Yes	Yes	NAT	3	1	0	3	7

COUNTY #37 - MARATHON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Big Bass	174	6	No	No	NAT	5	2	0	2	9
5	Big Eau Pleine	6830	46	Yes	Yes	IMP	6	3	4	7	20
15	Du Bay	6700	<30	Yes	Yes	IMP	3	2	0	2	7*
	Half Moon	800	12	Yes	Yes	IMP	3	2	0	2	7
24	Mayflower	100	14	No	No	NAT	5	2	3	2	12
27	Mosinee	200	<30	Yes	Yes	IMP	3	2	0	4	9*
37	Pike	208	33	Yes	Yes	NLLC	6	2	4	2	14
57	Wausau	1900	<30	Yes	Yes	IMP	3	2	0	3	8*

COUNTY #38 - MARINETTE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
6	Bagley	281	20	Yes	Yes	IMP	3	2	0	2	7
29	Caldron Falls	1180	40	Yes	Yes	IMP	4	1	0	0	5
35	Chalk Hills	300	35	Yes	Yes	IMP	4	2	0	0	6
42	Coleman	246	67	Yes	Yes	NLLC	4	1	0	2	7
67	Gilas	125	84	No	No	NAT	4	0	0	0	4
72	Grand Rapids	202	23	Yes	Yes	IMP	3	2	0	0	5
84	High Falls	1498	54	Yes	Yes	IMP	4	1	0	0	5
85	Hilbert	247	38	No	No	NAT	4	0	0	0	4
96	Johnson Falls	68	40	Yes	Yes	IMP	4	2	0	0	6
133	Mary	167	20	Yes	Yes	NAT	3	2	0	2	7
147	Montana	135	28	Yes	Yes	NAT	3	2	0	0	5
120	Lake Quinnesee Flowage	67	40	Yes	Yes	IMP	4	2	0	0	6
163	Noquebay	2162	54	Yes	Yes	NLLC	4	2	0	2	8
172	Peshtigo	232	15	Yes	Yes	IMP	3	2	0	2	7
196	Sandstone	153	39	Yes	Yes	IMP	4	2	0	2	8
213	Sturgeon Falls	200	40	Yes	Yes	IMP	4	2	0	0	6
216	Thunder	135	62	Yes	Yes	NAT	4	0	0	0	4
218	Town Corner	175	12	No	Yes	NAT	5	1	3	2	11
225	Upper Scott	283	17	Yes	Yes	IMP	3	2	0	2	7
230	White Rapids	449	32	Yes	Yes	IMP	4	2	0	0	6

COUNTY #39 - MARQUETTE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Buffalo	2447	15	Yes	Yes	IMP	1	3	0	2	6
10	Crystal	124	60	Yes	Yes	NAT	2	1	0	0	3
17	Harris Pond	245	10	Yes	Yes	IMP	1	2	0	6	9
22	Lawrence Pond	231	12	Yes	Yes	IMP	3	1	0	2	6
26	Montello	286	17	Yes	Yes	IMP	1	1	0	3	5
33	Neshkoro	192	12	Yes	Yes	IMP	3	3	0	9	15
54	Tuttle	167	36	No	No	NAT	4	1	0	0	5

COUNTY #40 - MENOMINEE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Bass (Lower)	106	35	No	No	NAT	2	1	0	0	3
3	Bass (Upper)	120	47	Yes	Yes	NAT	0	1	0	0	1
19	Lamotte	185	71	No	No	NAT	2	0	0	0	2
27	Moshawquit	296	30	Yes	Yes	NAT	1	2	0	0	3
29	Neopit	202	10	Yes	Yes	IMP	0	2	0	0	2
33	Pine	152	3	No	Yes	NAT	3	4	3	4	14

COUNTY #42 - MONROE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
7	Lake Tomah	225	19	Yes	Yes	IMP	3	3	0	6	12
8	Monroe Co. Flowage	263	8	Yes	Yes	IMP	3	3	3	0	9
52	14/16	118	12		Yes	IMP	5	2	0	0	7
56	23/4	120	<30	Yes		NLLC	3	2	0	2	7*
71	12/14	100	13	Yes	Yes	IMP	3	2	0	0	5
80	14/13	101	10	Yes	Yes	IMP	5	2	0	2	9
96	12/1	173	17	Yes	Yes	IMP	3	2	0	0	5
107	7/8	201	8	Yes	Yes	IMP	5	2	0	0	7
115	31/14	162	9	Yes	Yes	IMP	5	2	0	0	7

COUNTY #43 - OCONTO

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Anderson	171	40	Yes	Yes	NLLC	4	2	0	0	6
2	Archiband	430	58	Yes	No	NAT	4	0	0	0	4
7	Bass	149	50	Yes	No		4	0	0	0	4
13	Berry	143	20	No	No	NAT	3	2	0	0	5
17	Boot	263	40	No	No	NAT	4	0	0	0	4
18	Boulder	362	11	No	Yes	NAT	3	0	0	0	3
28	Chain	31	50	No	Yes	NAT	4	0	0	0	4
31	Christy	387	10	No	Yes	NAT	5	2	3	2	12
32	Chute Pond	417	18	Yes	Yes	IMP	3	2	0	2	7
36	Crooked	143	43	Yes	Yes	NLLC	4	1	0	0	5
69	Horn	132	13	No	Yes	NAT	3	2	0	0	5
71	Impassable	84	5	Yes	Yes	NLLC	5	2	3	2	12
81	John	103	26	Yes	Yes	NAT	3	1	0	2	6
75	Kelly	361	41	Yes	Yes	NAT	2	0	0	0	2
84	Lee	91	40		Yes	NLLC	4	0	0	0	4
106	Machickanee	435	23	Yes	Yes	IMP	5	2	3	5	15
108	Maiden	290	60	Yes	Yes	NAT	4	0	0	0	4
121	Oconto Falls Pond	123	29	Yes	Yes	IMP	3	2	0	0	5
124	Paya	121	40	No	No	NAT	4	0	0	0	4
131	Pickerel	127	15	Yes	Yes	NLLC	3	2	0	0	5
140	Reservoir Pond	409	13	Yes	Yes	IMP	3	2	0	2	7

COUNTY #43 - OCONTO Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
142	Rost	86	24	No	No	NAT	3	0	0	0	3
149	Shay	50	36	No	No	NAT	4	0	0	0	4
160	Surprise	70	30	No	No	NAT	3	0	0	0	3
	Townsend Flowage	303	27	Yes	Yes	IMP	3	2	0	2	7
175	Waubee	137	20	No	No	NAT	3	0	0	0	3
178	Wescott	38	29	No	Yes	NAT	3	0	0	2	5
181	Wheeler	305	40	No	No	NAT	4	0	0	0	4
171	Upper Wheeler Pond	140	10	Yes	Yes	IMP	3	2	0	0	5
183	White Potato	1011	11	No	No	NAT	5	1	3	2	11

COUNTY #44 - ONEIDA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Aldridge	134	12	No	Yes	NAT	3	2	0	2	7
7	Alva	201	36	No	No	NAT	4	1	0	2	7
15	Bass	124	20	Yes	Yes	IMP	3	2	0	0	5
20	Bear	675	29	No	Yes	NAT	3	2	0	2	7
21	Bearskin	384	26	Yes	Yes	NAT	3	2	0	2	7
26	Big	867	30	Yes	Yes	NLLC	3	2	0	0	5
27	Big Carr	213	71	No	No	NAT	0	0	0	0	0
28	Big Fork	624	22	Yes	Yes	NLLC	3	2	0	0	5
29	Big Stone	567	57	Yes	Yes	NLLC	4	2	0	0	6
30	Birch	180	24	Yes	Yes	NAT	3	2	0	2	7
31	Bird	103	40	No	No	NAT	4	0	0	0	4
32	Blue	433	56	No	No	NAT	4	0	0	0	4
37	Bolger	119	39	No	No	NAT	4	0	0	0	4
38	Boom	437	30	Yes	Yes	IMP	3	2	0	0	5
39	Booth	207	34	No	Yes	NAT	4	2	0	2	8
46	Buckskin	634	22	No	Yes	NAT	3	2	3	2	10
47	Buffalo	104	27	No	No	NAT	3	2	0	0	5
52	Burrows	156	26	No	No	NAT	3	2	0	2	7
55	Carrol	335	31	Yes	Yes	NLLC	4	2	0	2	8
56	Chain	213	18	Yes	Yes	NLLC	3	2	0	2	7
63	Clear Lake	212	21	No	No	NAT	3	2	0	2	7

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
64	Clear	1049	100	No	No	NAT	4	0	0	0	4
66	Clearwater	343	29	No	Yes	NAT	3	2	0	0	5
67	Columbus	670	26	Yes	Yes	NAT	3	2	0	0	5
73	Crescent Lake	612	37	No	Yes	NAT	4	2	0	2	8
75	Crooked	176	17	No	Yes	NAT	3	2	3	3	11
77	Crystal	112	7	Yes	Yes	NAT	5	2	0	2	9
82	Dam	716	30	Yes	Yes	NLLC	3	2	0	2	7
84	Deer	175	17	Yes	Yes	NLLC	3	2	0	0	5
88	Diamond	124	17	Yes	Yes	NAT	3	2	0	2	7
89	Dog	241	10	Yes	Yes	NAT	3	2	0	0	5
99	East Horse Head	184	26	No	Yes	NAT	3	2	0	0	5
106	Emma	223	17	No	No	NAT	3	2	0	2	7
109	Fifth	240	9	Yes	Yes	NLLC	3	2	0	0	5
113	Flannery	112	33	No	No	NAT	4	0	0	2	6
116	Four Mile	252	18	Yes	Yes	NAT	3	2	0	0	5
117	Fourth	258	9	Yes	Yes	NLLC	3	2	0	0	5
119	Franklin	161	25	No	No	NAT	3	2	0	0	5
121	Fuller	101	4	No	Yes	NAT	5	2	3	3	13*
123	Garth	114	22	No	No	NAT	3	2	0	4	9
125	George	435	26	Yes	Yes	NAT	3	2	0	2	7
127	Gilmore	301	24	Yes	Yes	NLLC	3	2	0	2	7

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
128	Ginty	131	12	Yes	Yes	NAT	3	2	0	2	7
132	Great Bass	118	15	No	No	NAT	3	2	0	2	7
136	Hancock	259	22	Yes	Yes	NLLC	3	2	0	5	10
138	Hasbrook	302	50	No	Yes	NAT	4	2	0	0	6
148	Hodstradt	126	37	No	No	NAT	4	0	0	0	4
151	Horsehead	356	12	No	Yes	NLLC	5	2	3	9	19
155	Indian	397	26	No	Yes	NAT	3	2	0	2	7
158	Island	297	22	Yes	Yes	NLLC	3	2	0	2	7
163	Jennie Weber	237	9	Yes	Yes	NAT	3	2	0	2	7
166	Julia	238	19	No	No	NAT	3	2	0	2	7
169	Kathan	189	15	Yes	Yes	NAT	3	2	0	2	7
170	Katherine	555	32	No	Yes	NLLC	4	2	0	0	6
171	Kawaguesaga	801	41	Yes	Yes	NLLC	4	2	0	2	8
172	Killarney	421	8	Yes	Yes	IMP	5	2	3	0	10
173	Lake Creek	172	12	Yes	Yes	IMP	3	2	0	0	5
178	Laurel	149	11	Yes	Yes	NLLC	3	2	0	0	5
187	Little Bearskin	174	23	Yes	Yes	NAT	3	2	0	2	7
190	Little Fork	336	30	Yes	Yes	NLLC	3	2	0	2	7
198	Little Tomahawk	163	50	No	Yes	NLLC	4	1	0	0	5
199	Lone Stone	172	29	No	Yes	NAT	3	2	0	2	7
202	Long	113	58	No	No	NAT	4	0	0	0	4

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
203	Long	115	31	No	No	NAT	4	0	0	0	4
205	Long	588	22	Yes	Yes	NLLC	3	2	0	2	7
209	Lost	155	14	Yes	Yes	NAT	5	2	0	2	9
211	Lower Kaubashine	187	36	Yes	Yes	NAT	4	2	0	0	6
215	Madeline	154	25	Yes	Yes	NLLC	3	2	0	2	7
217	Manson	236	54	Yes	Yes	NAT	4	0	0	0	4
218	Maple	142	15	No	Yes	NLLC	5	2	3	2	12
226	McCormick	110	8	Yes	Yes	NAT	5	2	3	0	10
228	McNaughton	120	7	No	Yes	NAT	5	2	3	2	12
229	Medicine	411	42	Yes	Yes	NLLC	4	2	0	2	8
230	Mercer	254	23	Yes	Yes	NAT	3	2	0	2	7
232	Mid	215	13	No	Yes	NLLC	5	2	3	2	12
234	Mildred	191	45	No	No	NAT	4	0	0	0	4
241	Minoqua	1285	60	Yes	Yes	NLLC	4	1	0	2	7
244	Moen	460	11	Yes	Yes	NLLC	3	2	0	0	5
251	Muskellunge	283	23	No	Yes	NAT	3	2	0	0	5
254	Neptune	126	7	Yes	Yes	NAT	5	2	0	2	9
257	Nokomis	1950	18	Yes	Yes	IMP	3	2	0	2	7
258	North Nokomis	468	73	No	Yes	NAT	4	0	0	0	4
261	North Two	150	43	No	No	NAT	4	0	0	0	4
266	Oneida	255	34	Yes	Yes	NLLC	4	2	0	0	6

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
268	Oscar Jennie	104	24	No	No	NAT	3	0	0	0	3
271	Pelican	3585	39	Yes	Yes	NLLC	4	2	0	2	8
279	Pickerel	477	17	Yes	Yes	NLLC	3	2	0	2	7
280	Pier	257	12	Yes	Yes	NLLC	3	2	0	0	5
282	Pine	240	32	Yes	Yes	NAT	4	2	0	0	6
283	Pine	203	23	No	No	NAT	3	2	0	0	5
284	Planting Ground	1015	18	Yes	Yes	NLLC	3	2	0	2	7
289	Rainbow Flowage	2035	28	Yes	Yes	IMP	3	2	0	2	7
290	Range Line	130	21	Yes	Yes	NLLC	3	2	0	2	7
291	Rhinelander Flowage	1326	12	Yes	Yes	IMP	3	2	0	2	7
292	Rice	118	3	Yes	Yes	NLLC	5	2	0	2	9*
293	Rice River Flowage	1150	17	Yes	Yes	IMP	3	2	0	2	7
300	Round	152	11	Yes	Yes	NLLC	3	2	0	2	7
305	Sand	544	20	Yes	Yes	NLLC	3	2	0	0	5
307	Second	111	11	Yes	Yes	NLLC	3	2	0	0	5
309	Seven Mile	240	36	Yes	Yes	NLLC	4	2	0	2	8
310	Seventeen	172	33	No	No	NAT	4	1	0	0	5
313	Shepard	179	18	Yes	Yes	NAT	3	2	0	0	5
315	Shisheogama	716	42	Yes	Yes	NAT	4	2	0	2	8
322	Skunk	130	7	No	Yes	NLLC	5	2	3	2	12
324	Snowden	135	12	No	No	NAT	5	0	3	0	8

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
325	Soo	135	13	No	No	NAT	3	2	0	0	5
330	South Two	223	70	No	No	NAT	4	0	0	0	4
331	Spider	125	27	No	Yes	NAT	3	0	0	0	3
332	Spirit	342	7	Yes	Yes	NLLC	5	2	0	2	9*
336	Spur	113	3	Yes	Yes	NAT	5	2	3	2	12
337	Squash	392	81	No	No	NAT	4	0	0	0	4
339	Squaw	785	22	Yes	Yes	NLLC	3	2	0	2	7
340	Squirrel	1352	45	Yes	Yes	NLLC	4	2	0	2	8
342	Starks Flowage	120	9	Yes	Yes	IMP	3	2	0	2	7
344	Stella	425	15		Yes	NAT	5	2	3	2	12
346	Stone	189	12	Yes	Yes	NLLC	3	2	0	0	5
347	Stone	248	10	Yes	Yes	NAT	3	2	0	0	5
351	Sugar Camp	545	38	No	No	NAT	4	0	0	0	4
355	Swamp	296	8	Yes	Yes	NLLC	3	2	0	2	7
357	Swampsauger	141	12	Yes	Yes	NAT	3	2	0	0	5
359	Sweeney	187	18	Yes	Yes	NLLC	5	2	3	2	12
363	Third	103	14	Yes	Yes	NLLC	3	2	0	0	5
364	Thompson	382	35	Yes	Yes	NAT	4	2	0	0	6
366	Thunder	172	12	Yes	Yes	IMP	3	2	0	2	7
367	Thunder	1768	9	No	Yes	NLLC	3	2	0	2	7
371	Tomahawk	3627	79	Yes	Yes	NLLC	4	0	0	0	4

COUNTY #44 - ONEIDA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
372	Tom Doyle	108	27	Yes	Yes	NAT	3	2	0	2	7
374	Town Line	150	30	Yes	Yes	NLLC	3	2	0	2	7
376	Two Sisters	705	64	No	Yes	NAT	4	0	0	0	4
378	Upper Kaubashine	183	57	No	Yes	NAT	4	0	0	0	4
383	Virgin	266	20	Yes	Yes	NLLC	3	2	0	2	7
387	West Horsehead	145	26	Yes	Yes	NAT	3	2	0	2	7
391	Whitefish	185	31	Yes	Yes	NLLC	4	2	0	2	8
395	Willow	395	6	Yes	Yes	NLLC	3	2	0	2	7
396	Willow Flowage	5135	22	Yes	Yes	IMP	3	2	0	0	5
398	Wind Pudding	196	34	No	No	NAT	4	0	0	2	6

COUNTY #46 - OZAUKEE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
17	Mud Lake	245	4	Yes	Yes	NAT	5	2	3	0	10

COUNTY #49 - POLK

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
5	Antler	101	22	No	No	NAT	5	2	0	0	7
6	Apple River Flowage	639	18	Yes	Yes	IMP	1	2	0	3	6
15	Balsam	2054	37	Yes	Yes	NLLC	2	2	0	5	9
20	Bass	138	19	No	No	NAT	3	2	3	2	10
22	Beartrap	241	25		Yes	NAT	1	1	0	4	6
25	Big	259	24		Yes	NLLC	1	1	0	3	5
26	Big Butternut	378	19	Yes	Yes	NLLC	5	2	0	5	12
35	Blake	302	14	Yes	Yes	NLLC	5	2	0	3	10
36	Blom	210	13	No	No	NAT	3	1	0	3	7
37	Bone	1781	43	Yes	Yes	NAT	2	1	0	2	5
70	Cedar	1100	32	Yes	Yes	NLLC	2	2	0	2	6
72	Church Pine	107	45		Yes	NAT	2	1	0	0	3
73	Clam Falls Flowage	127	14	Yes	Yes	IMP	1	2	0	2	5
110	Deer	807	46	No	Yes	NLLC	2	1	0	2	5
113	Diamond	126	15	No	No	NAT	5	2	0	2	9
116	East	228	15	Yes	Yes	NAT	3	2	3	2	10
337	Freedom #2	106	4	No	No	NAT	5	2	3	2	12*
170	Garfield	120	8	No	No	NAT	5	2	3	2	12*
182	Glenton	128	10	Yes	Yes	NAT	5	2	3	3	13
187	Half Moon	579	60	Yes	Yes	NLLC	2	2	0	2	6
196	Horse	228	11	Yes	Yes	NAT	5	2	0	3	10

COUNTY #49 - POLK

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
197	Horseshoe	377	57	No	No	NAT	2	1	0	2	5
200	Indian Head Flow	776	57	Yes	Yes	IMP	2	2	0	0	4
252	Largon	129	10	Yes	Yes	NLLC	1	2	3	2	8
257	Little Butternut	189	23	Yes	Yes	NAT	1	2	0	2	5
264	Long	272	17	No	No	NAT	3	2	0	2	7
265	Long Trade	153	13	Yes	Yes	IMP	5	2	0	2	9
274	Loveless	141	20	No	Yes	NLLC	1	2	3	2	8
292	Magnor	231	26	Yes	No	NAT	3	2	0	0	5
339	North	119	9	No	Yes	NAT	5	2	3	3	13
341	North Twin	135	27	Yes	Yes	NAT	3	2	0	0	5
350	Pike	159	33		Yes	NAT	4	2	0	2	8
351	Pine	153	53	No	No	NAT	2	1	0	2	5
353	Pipe	281	68	No	No	NAT	0	1	0	0	1
355	Poplar	125	34	No	No	NAT	4	1	0	0	5
358	Round	1015	17	Yes	Yes	NAT	5	2	0	3	10
365	Sand	187	58	No	No	NAT	2	2	0	2	6
371	Somers	101	12	Yes	Yes	NAT	1	2	0	3	6
389	Straight	107	12	No	Yes	NAT	1	2	0	0	3
401	Wapogasset	1186	32	Yes	Yes	NLLC	2	2	0	5	9
425	White Ash	153	9	Yes	Yes	NAT	5	2	0	5	12
426	Wild Goose	181	12	No	No	NAT	5	2	3	2	12

COUNTY #50 - PORTAGE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
15	Emily	96	35	Yes	Yes	NAT	4	1	0	2	7
30	McDill Pond	261	15	Yes	Yes	IMP	3	3	0	4	10
69	Wisconsin River	220	25	Yes	Yes	IMP	3	3	0	4	10
70	Wisconsin River	2093	25	Yes	Yes	IMP	3	3	0	5	11
	Little Eau Pleine	600	?	Yes	Yes	IMP	0	3	0	0	

COUNTY #51 - PRICE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
15	Big Dardis	144	23	Yes	Yes	NAT	0	2	0	0	2
16	Blockhouse	242	12	Yes	Yes	NAT	0	2	0	2	4
19	Butternut	1006	32	Yes	Yes	NLLC	2	2	0	7	11
25	Cochram	111	16	No	Yes	NAT	1	2	0	0	3
29	Cranberry	512	18	Yes	Yes	NLLC	5	2	3	2	12
31	Crowley Flowage	422	23	Yes	Yes	IMP	1	2	0	2	5
36	Deer	145	18	No	Yes	NAT	0	2	0	0	2
40	Duroy	338	16	Yes	Yes	NLLC	1	2	0	2	5
52	Hay	101	6	Yes	Yes	NAT	1	4	0	0	5
54	Hultman	181	14	Yes	Yes	NAT	1	2	0	2	5
62	Lac Sault Dore	561	21	Yes	Yes	IMP	3	2	0	0	5
66	Le Tourneau	124	16	Yes	Yes	NAT	1	2	3	0	6
70	Long	418	54	Yes	Yes	NLLC	2	2	0	0	4
71	Long	240	49	Yes	Yes	NAT	4	1	0	0	5
90	Musser	563	15	Yes	Yes	IMP	1	2	0	0	3
96	North Spirit	213	22	Yes	Yes	NAT	1	2	0	0	3
108	Pike	848	18	Yes	Yes	NAT	1	2	0	0	3
109	Pixley Flowage	193	23	Yes	Yes	IMP	3	2	0	3	8
117	Riley	182	8	No	Yes	NAT	5	3	3	0	11
119	Round	718	24	Yes	Yes	NLLC	1	2	0	0	3
122	Sailor	165	6	Yes	Yes	NAT	5	2	3	2	12

COUNTY #51 - PRICE Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
123	Sailor Creek Flowage	155	10	Yes	Yes	IMP	1	2	0	3	6
125	Schnur	158	27	No	Yes	NAT	0	2	0	4	6
127	Sixteen	119	5	No	Yes	NAT	5	2	3	0	10
128	Solberg	859	16	Yes	Yes	IMP	0	2	0	0	2
129	Spirit	126	9	Yes	Yes	NLLC	3	2	3	0	8
131	Squaw Creek Flowage	150	7	Yes	Yes	IMP	0	2	0	0	2
139	Thompson	111	25	Yes	Yes	NAT	3	2	0	0	5
145	Tucker	118	32	Yes	Yes	NAT	4	2	0	0	6
146	Turner	203	15	Yes	Yes	NAT	5	2	0	0	7
148	Upper Park Falls	431	17	Yes	Yes	IMP	0	2	0	0	2
154	Wilson	351	11	Yes	Yes	IMP	0	2	0	0	2
156	Worcester	100	37	Yes	Yes	NAT	6	2	0	0	8

COUNTY #52 - RACINE

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Bohners	124	30	Yes	Yes	NLLC	3	1	0	2	6
4	Browns	396	44	Yes	Yes	NLLC	4	1	0	3	8
5	Buena	241	8	Yes	Yes	IMP	1	2	0	3	6
7	Eagle	520	15	Yes	Yes	NLLC	5	3	3	9	20
8	Echo	71	9	Yes	Yes	IMP	1	3	0	2	6
11	Long	123	5	Yes	Yes	NAT	5	3	3	6	17
16	Tichigan	268	63	Yes	Yes	NLLC	6	2	4	9	21
17	Waubeesee	129	73	Yes	Yes	NLLC	4	1	0	2	7
18	Wind	936	47	Yes	Yes	NLLC	4	1	0	2	7

COUNTY #53 - RICHLAND

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
8	Lawson Pond	153	8	Yes	Yes	IMP	3	3	0	5	11
10	Sand Prairie Slough	100	5	Yes	Yes	NAT	3	3	3	2	11

COUNTY #55 - RUSK

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Amacoy	278	20	Yes	Yes	NAT	1	2	0	2	5
3	Audie	128	32	No	No	NAT	2	2	0	0	4
9	Big Falls	369	45	Yes	Yes	IMP	2	2	0	0	4
23	Dairyland Reservoir	1745	70	Yes	Yes	IMP	2	2	0	0	4
25	Fireside	302	30	Yes	Yes	NAT	1	2	0	2	5
26	Fish	115	40	No	No	NAT	4	1	0	0	5
34	Island	526	54	Yes	Yes	NAT	0	1	0	2	3
36	Ladysmith	288	19	Yes	Yes	IMP	0	2	0	0	2
37	Lea	232	9	Yes	Yes	IMP	5	2	0	2	9
43	McCann	133	38	Yes	Yes	NAT	2	2	0	2	6
55	Potato Creek	174	5	Yes	Yes	IMP	1	2	0	4	7
56	Potato	534	40	Yes	Yes	NAT	4	2	0	2	8
57	Pulaski	126	40	No	No	NAT	2	2	0	0	4
58	Round	105	5	No	No	NAT	5	2	0	2	9
51	Sand	262	100	No	No	NAT	0	1	0	0	1
70	Thornapple	268	19	Yes	Yes	IMP	0	2	0	2	4
75	Washington Creek	165	5	Yes	Yes	IMP	3	2	0	2	7

COUNTY #56 - ST. CROIX

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Bass	301	33	No	No	NAT	6	0	0	0	6
28	St. Croix	4668	60	Yes	Yes	NLLC	0	2	0	0	2
30	Little Falls	172	18	Yes	Yes	IMP	5	2	0	0	7
31	Mallalieu	282	17	Yes	Yes	IMP	1	2	0	0	3
34	New Richmond	142	12	Yes	Yes	IMP	1	0	0	6	7
36	Pine	107	21				5	3	3	2	13*
49	Squaw	129	32				6	3	4	2	15*
62	Spring Valley	126	29	Yes	Yes	IMP	5	3	0	2	10*

COUNTY #57 - SAUK

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
5	Delton	254	16	Yes	Yes	IMP	3	2	0	5	10
6	Devil's	357	44	Yes	No	NAT	0	0	0	2	2
19	Redstone	600	40	Yes	Yes	IMP	6	3	4	9	22
24	White Pond	104	23	Yes	Yes	IMP	3	3	0	5	11

COUNTY #58 - SAWYER

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
3	Barber	238	21	Yes	Yes	NAT	1	2	0	2	5
4	Barker	238	12	Yes	Yes	NAT	0	2	0	0	2
15	Black	129	15	Yes	Yes	NLLC	1	2	0	2	5
16	Black Dan	128	37		Yes	NAT	2	1	0	2	5
17	Blaisdell	370	15	Yes	Yes	NAT	0	2	0	2	4
19	Blueberry	280	29	No	No	NAT	1	1	0	0	2
23	Brunet	126	12	Yes	Yes	IMP	1	2	0	2	5
33	Callahan	106	18	Yes	Yes	NLLC	1	2	0	0	3
41	Lake Chetac	2149	30	Yes	Yes	NAT	1	2	0	2	5
43	Chippewa	15300	82	Yes	Yes	IMP	2	2	4	0	8
48	Connor	408	87	Yes	Yes	NLLC	2	1	0	0	3
55	Deer	423	18	Yes	Yes	NLLC	5	2	3	0	10
57	Devils	188	6		Yes	NAT	5	2	3	3	13
58	Durphee	193	16	No	No	NLLC	1	2	3	7	13
64	Evergreen	200	25	Yes	Yes	NAT	1	2	0	0	3
68	Fishtrap	197	8	Yes	Yes	NLLC	1	2	0	0	3
73	Ghost	372	12	Yes	Yes	IMP	1	2	0	2	5
83	Grindstone	3111	59	Yes	Yes	NAT	0	1	0	0	1
87	Ham	100	28	No	No	NAT	1	2	0	0	3
91	Hayward	247	17	Yes	Yes	IMP	0	1	0	2	3
101	Hunter	126	11	Yes	Yes	NAT	0	2	0	0	2

COUNTY #58 - SAWYER Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
114	Lac Court Oreilles	5039	90	Yes	Yes	NAT	0	1	0	2	3
175	Lake of the Pines	223	39	Yes	Yes	NAT	2	2	0	0	4
116	Little Court Oreilles	240	46	Yes	Yes	NAT	0	1	0	2	3
120	Little Round	174	38	Yes	Yes	NLLC	2	1	0	2	5
123	Little Sissabagama	299	75	Yes	Yes	NAT	0	1	0	0	1
127	Lost Land	1304	21	Yes	Yes	NAT	1	2	0	0	3
129	Lower Clam	229	22	Yes	Yes	NLLC	1	2	0	2	5
134	Lower Twin	247	30	Yes	Yes	NLLC	3	1	0	2	6
137	Mason	190	39	Yes	Yes	NAT	4	2	0	2	8
145	Moose	1670	21	Yes	Yes	IMP	0	2	0	0	2
153	Mud	480	15	Yes	Yes	NLLC	1	2	0	2	5
158	Nelson	2503	33	Yes	Yes	IMP	4	2	0	2	8
160	North	129	30		Yes	NAT	3	2	3	0	8
164	Pacwawong	187	8	Yes	Yes	IMP	1	2	0	3	6
169	Perch	129	24	No	No	NAT	0	2	0	0	2
179	Placid	160	30	No	Yes	NLLC	3	1	0	2	6
182	Price	715	14	Yes	Yes	IMP	1	2	0	0	3
183	Radisson	255	12	Yes	Yes	IMP	0	2	0	0	2
188	Round	2784	70	Yes	Yes	NLLC	0	1	0	0	1
193	Sand	928	50	Yes	Yes	NLLC	2	1	0	2	5
197	Sissabagama	719	48		Yes	NLLC	2	1	0	0	3

COUNTY #58 - SAWYER Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
198	Smith	323	29	Yes	Yes	NAT	1	2	0	0	3
203	Spider	1454	64	Yes	Yes	NLLC	2	1	0	0	3
206	Spring	220	18	Yes	Yes	NLLC	5	2	3	0	10
208	Squaw	208	32	Yes	Yes	NAT	2	1	0	2	5
209	Star	104	4	Yes	Yes	NAT	3	2	3	0	8
213	Swamp	258	9	No	Yes	NAT	5	2	3	0	10
215	Teal	1049	31	Yes	Yes	NAT	2	2	0	0	4
219	Tiger Cat	224	11	Yes	Yes	IMP	1	2	0	6	9
220	Totogatic	243	17	Yes	Yes	IMP	1	2	0	2	5
227	Two Boys	117	37		Yes	NAT	4	1	0	0	5
231	Upper Twin	299	27	Yes	Yes	NAT	1	2	0	2	5
239	Whitefish	785	105	Yes	Yes	NAT	0	0	0	0	0
241	Wilson	103	14	Yes	Yes	NAT	3	2	0	3	8
242	Windfall	102	16	No	No	NAT	1	2	0	0	3
243	Windigo	522	51	No	No	NAT	2	2	0	2	6
434	10/9	248	7	No	Yes	IMP	5	2	3	2	12

COUNTY #59 - SHAWANO

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
24	Loon	278	23	Yes	Yes	NAT	1	2	0	0	3
36	Pella Pond	115	14	Yes	Yes	IMP	0	2	0	2	4
37	Pensaukee	104	26		Yes	NAT	1	2	3	2	8
38	Pine	209	35	Yes	Yes	NLLC	2	2	0	0	4
42	Shawano	6178	42	Yes	Yes	NAT	2	2	0	5	9
46	Tigerton	167	14	Yes	Yes	IMP	0	2	0	2	4
50	Weed Dam	207	25	Yes	Yes	IMP	1	2	0	0	3
51	White	181	12	No	No	NAT	5	2	3	3	13*
52	White Clay	256	45		Yes	NAT	2	2	0	0	4
54	Wolf River	223	10	Yes	Yes	IMP	0	2	0	0	2

COUNTY #60 - SHEBOYGAN

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
8	Crystal	114	61	Yes	Yes	NAT	4	1	0	5	10
10	Big Elkhart	300	113	Yes	Yes	NAT	4	1	0	5	10
11	Ellen	110	48	Yes	Yes	NAT	4	1	0	4	9
34	Random	209	19	Yes	Yes	NAT	5	1	3	2	11
38	Sheboygan Marsh	674	4	Yes	Yes	NAT	5	3	3	2	13

COUNTY #61 - TAYLOR

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
10	Chequamegon Waters	2730	22	Yes	Yes	IMP	1	2	3	0	6
48	Mondeaux	416	10	Yes	Yes	IMP	3	2	0	2	7
69	Rib	320	9	Yes	Yes	NLLC	3	3	3	5	14
81	Steve Creek	140	8	Yes	Yes	IMP	5	2	3	0	10

COUNTY #62 - TREMPEALEAU

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
9	Marinuka	107	9	Yes	Yes	IMP	1	3	0	9	13

COUNTY #64 - VILAS

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
6	Alder	274	33	Yes	Yes	NLLC	4	2	0	2	8
7	Allequash	405	33	Yes	Yes	NAT	4	1	0	2	7
11	Amik	187	10	Yes	Yes	NAT	3	2	0	0	5
14	Annabelle	186	30	Yes	Yes	NAT	3	2	0	0	5
17	Anvil	380	40	No	No	NAT	4	0	0	0	4
18	Apeekwa	188	10	Yes	Yes	NAT	3	2	0	2	7
19	Arbor Vitae, Big	1065	36	Yes	Yes	NAT	4	2	0	2	8
20	Arbor Vitae, Little	533	32	Yes	Yes	NLLC	4	2	0	2	8
21	Armour	319	53	Yes	Yes	NAT	4	0	0	0	4
28	Ballard	505	25	Yes	Yes	NAT	3	2	0	0	5
32	Bass	266	15	Yes	No	NAT	3	2	3	2	10
36	Bateau, Big	230	>30	No	No	NAT	4	1	0	0	5*
39	Bay, West	368	31	Yes	Yes	NLLC	4	2	0	2	8
52	Big	850	65	Yes	Yes	NAT	4	2	0	0	6
53	Big	723	30	Yes	Yes	NLLC	3	2	0	2	7
55	Birch	528	35	Yes	Yes	NAT	4	2	0	2	8
56	White Birch	117	27	Yes	Yes	NAT	3	2	0	0	5
56	Birch, Yellow	185	14	Yes	Yes	NLLC	3	2	0	0	5
58	Bittersweet	104	31	No	No	NAT	4	1	0	0	5
65	Bolton	138	36	Yes	No	NAT	4	2	0	0	6
66	Boot	284	14	Yes	Yes	NAT	3	2	0	2	7

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
69	Boulder	525	23	Yes	Yes	NAT	3	2	0	0	5
72	Brandy	110	44	Yes	Yes	NAT	4	2	0	2	8
74	Broken Bow	134	23	No	No	NAT	3	2	0	0	5
76	Buckatabon, Lower	352	16	Yes	Yes	NLLC	3	2	0	2	7
77	Buckatabon, Upper	477	30	Yes	Yes	NLIC	3	2	0	2	7
88	Canoe, (Lost)	249	41	Yes	Yes	NAT	4	1	0	0	5
90	Carlin	153	36	No	No	NAT	4	2	0	0	6
91	Carpenter	333	16	No	No	NAT	3	2	0	0	5
93	Catfish	991	26	Yes	Yes	NLLC	3	2	0	2	7
102	Circle Lily	223	35	Yes	Yes	NAT	4	2	0	0	6
104	Clear	518	39	Yes	No	NAT	4	1	0	0	5
108	Cochran	126	12	Yes	No	NAT	5	2	0	2	9
111	Content	244	14			NLLC	5	2	3	2	12
116	Crab	920	56	Yes	Yes	NAT	4	0	0	0	4
120	Cranberry	940	11	Yes	Yes	NLLC	3	2	0	2	7
123	Crooked, Big	383	50	Yes	Yes	NAT	2	0	0	0	2
124	Crooked, Big	682	34	Yes	Yes	NAT	4	0	0	0	4
125	Crooked, Little	153	20	Yes	Yes	NAT	3	2	0	2	7
133	Day	117	48	No	No	NAT	4	0	0	0	4
143	Deerskin	282	24	Yes	No	NLLC	3	2	0	2	7
148	Diamond	122	40	No	No	NAT	2	0	0	0	2

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
151	Dollar	105	15	No	No	NAT	3	2	0	0	5
160	Duck	109	18	Yes	Yes	NLLC	3	2	0	2	7
162	Eagle	591	27	Yes	Yes	NLLC	3	2	0	2	7
169	Ellerson, East	136	26	No	No	NAT	3	1	0	0	4
177	Erickson	106	18	Yes	No	NAT	3	2	0	0	5
179	Escanaba	288	25			NAT	3	2	0	0	5
187	Fence	3340	86	Yes	Yes	NAT	4	0	0	0	4
190	Finley	107	26	No	No	NAT	3	0	0	0	3
192	Fishtrap	329	41	Yes	Yes	NLLC	4	2	0	0	6
193	Flambeau	1145	49	Yes	Yes	NLLC	4	0	0	0	4
194	Flora	100	29	Yes	Yes	NAT	3	2	0	0	5
195	Forest	466	60	No	No	NAT	4	0	0	0	4
196	Found	326	20	Yes	Yes	NAT	3	2	0	2	7
199	Frank	141	24	No	No	NAT	3	0	0	0	3
208	Gibson, Big	116	15	No	No	NAT	3	1	0	0	4
213	Grassy	220	4	Yes	Yes	NAT	5	2	3	2	12
214	Gresham, Lower	149	12	Yes	Yes	NAT	3	2	0	2	7
216	Gresham, Upper	375	20	Yes		NAT	3	2	0	2	7
219	Gunlock	267	25	Yes	No	NAT	3	1	0	2	6
224	Harris	523	48	Yes	Yes	NAT	4	0	0	0	4
231	Helen	111	19	Yes	Yes	NAT	3	2	0	2	7

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
236	High	734	31	Yes	Yes	NLLC	4	1	0	0	5
241	Horsehead	229	50	Yes	Yes	NAT	4	0	0	0	4
245	Hunter	148	50	No	No	NAT	4	0	0	0	4
249	Ike Walton	1439	63	No	No	NAT	4	0	0	0	4
254	Interlaken, Long	368	65	Yes	Yes	NAT	4	0	0	0	4
255	Irving	403	8	Yes	Yes	NAT	5	2	3	2	12
256	Island	757	33	Yes	Yes	NLLC	4	2	0	0	6
257	Jag	158	14	No	No	NAT	3	0	0	0	3
262	John, Little	166	19	Yes	No	NAT	3	2	0	2	7
268	Jute	194	25	No	No	NAT	3	0	0	0	3
271	Katinka	172	60		Yes	NAT	4	0	0	0	4
273	Kentuck	995	40		Yes	NAT	0	2	0	2	4*
282	Lac Du Lune	407	56	No	No	NAT	2	0	0	0	2
283	Lac Vifux Desert	4280	38	Yes	Yes	NLLC	4	2	0	2	8
287	Landing	220	11	Yes	Yes	NAT	5	2	3	2	12
289	Laura	599	43	No	No	NAT	4	0	0	0	4
293	Long	872	95	Yes	Yes	NLLC	4	0	0	0	4
295	Lost	541	25	Yes	Yes	NLLC	3	2	0	2	7
299	Lynx	295	42	Yes	Yes	NAT	4	0	0	0	4
301	Mamie	360	18	Yes	Yes	NLLC	3	2	0	2	7
303	Manitowish	506	58	Yes	Yes	NLLC	4	1	0	0	5

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
304	Mann	250	22	No	Yes	NLLC	5	2	3	2	12
307	Maple, Sugar	129	27	No	No	NAT	3	0	0	0	3
315	McCullough	216	27	Yes	Yes	NAT	3	2	0	2	7
321	Meta	175	25	No	No	NAT	3	1	0	0	4
324	Mill	131	9	Yes	Yes	NAT	5	2	3	2	12
329	Mitien	140	23	No	No	NAT	3	2	0	0	5
332	Moon	124	40	No	No	NAT	4	0	0	0	4
334	Morton	163	29	Yes	Yes	NAT	3	2	0	2	7
335	Moss	196	29		Yes	NAT	3	2	0	2	7
341	Muskellunge	266	18	Yes	Yes	NAT	5	2	3	2	12
342	Muskellunge, Big	923	65		Yes	NAT	4	0	0	0	4
343	Muskesin	115	22	No	No	NAT	3	2	0	0	5
350	Nelson	104	50	No	No	NAT	4	0	0	0	4
353	Ninemile, Lower	646	5	Yes	Yes	IMP	3	2	0	2	7
356	Nixon	110	5	Yes	Yes	NAT	3	2	0	2	7
357	No Mans	225	31	Yes	Yes	NAT	4	2	0	2	8
358	Norwood	125	89	No	No	NAT	4	0	0	0	4
362	Oak, Black	549	63	Yes	Yes	NAT	2	0	0	0	2
366	Otter	199	20	Yes	Yes	NLLC	3	2	0	2	7
367	Oxbow	515	42	Yes	Yes	NAT	4	1	0	0	5
368	Palletie	173	65	No	No	NAT	2	0	0	0	2

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
369	Palmer	640	13	Yes	Yes	NAT	3	2	0	2	7
370	Papoose	428	65	No	Yes	NAT	4	0	0	0	4
372	Partridge	228	14	No	Yes	NAT	3	2	0	2	7
379	Pickerel	273	24	Yes	Yes	NAT	3	2	0	2	7
381	Pike, Dead	317	59	Yes	Yes	NAT	2	2	0	0	4
386	Pine, Lone	142	41	Yes	Yes	NAT	4	2	0	0	6
388	Pioneer	415	27	Yes	Yes	NLLC	3	2	0	2	7
390	Plum	938	48	Yes	Yes	NAT	4	0	0	0	4
391	Plummer	211	55	No	No	NAT	4	0	0	0	4
393	Pokegama	1052	65	Yes	Yes	NAT	4	0	0	2	6
395	Portage, Big	601	38	No	No	NAT	4	0	0	0	4
396	Portage, Little	170	11	Yes	Yes	NAT	3	2	0	2	7
399	Presque Isle	1280	80	Yes	Yes	NAT	4	0	0	0	4
404	Rainbow	146	36	Yes	Yes	NAT	4	1	0	2	7
408	Razorback	372	28	No	No	NAT	3	0	0	0	3
412	Rest	640	49	Yes	Yes	NLLC	4	2	0	2	8
416	Rice, Scattering	280	17	Yes	Yes	NLLC	3	2	0	2	7
417	Rice, Wild	365	26	Yes	Yes	NAT	3	2	0	2	7
418	Roach	125	37	No	No	NAT	4	0	0	0	4
421	Rock	122	18	Yes	Yes	NAT	3	2	0	0	5
425	Ross	146	14	Yes	Yes	NAT	5	2	3	2	12

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
427	Round	116	25	Yes	Yes	NAT	3	0	0	0	3
432	St. Germain, Big	1463	35	Yes	Yes	NLLC	4	1	0	2	7
433	St. Germain, Little	956	56	Yes	Yes	NLLC	4	2	0	2	8
435	Sanborn	253	13		Yes	NAT	3	2	0	2	7
436	Sand, Big	1408	35	Yes	Yes	NAT	4	0	0	0	4
437	Sand, Little	107	32	No	Yes	NAT	4	0	0	2	6
438	Sand, White	728	68	Yes	Yes	NAT	4	0	0	0	4
439	Sand, White	1195	50	Yes	Yes	NLLC	4	0	0	0	4
446	Sherman	123	19	No	No	NAT	3	2	0	2	7
450	Snipe	223	15	No	No	NAT	3	2	0	2	7
456	Sparkling	127	64	No	No	NAT	2	0	0	0	2
457	Spectacle	160	37	No	No	NAT	4	0	0	0	4
458	Spider	256	41	Yes	Yes	NLLC	4	1	0	2	7
459	Spider, Little	225	28	No	Yes	NAT	3	0	0	0	3
462	Spring	205	11	Yes	Yes	NAT	3	2	0	0	5
467	Star	1150	67	Yes	Yes	NLLC	4	0	0	0	4
468	Star, Little	244	63	Yes	Yes	NLLC	4	0	0	0	4
472	Stateline	199	67	No	Yes	NAT	4	0	0	0	4
473	Statenaker	202	50			NAT	4	0	0	0	4
474	Stearns	217	16	No	No	NAT	3	0	0	0	3
477	Stone	134	21	Yes	Yes	NLLC	3	2	0	2	7

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
478	Stone, Crawling	1460	80	Yes	Yes	NAT	4	0	0	0	4
479	Stone, Little Crawl	116	48	No	Yes	NAT	4	0	0	0	4
483	Stormy	525	61	No	No	NAT	2	0	0	0	2
488	Sugarbush, Lower	180	40	Yes	Yes	NAT	4	0	0	2	6
489	Sugarbush, Middle	265	55	Yes	Yes	NAT	4	0	0	2	6
490	Sugarbush, Upper	142	30	Yes	Yes	NAT	3	0	0	2	5
493	Sunset	185	43	No	No	NAT	4	0	0	0	4
495	Tamarack, Little	200	16	Yes	Yes	IMP	3	2	0	0	5
496	Tambling	169	11	No	Yes	NAT	5	2	3	2	12
500	Tenderfoot	461	36	Yes	Yes	NAT	4	2	0	2	8
503	Tippecanoe	155	34	No	No	NAT	4	0	0	0	4
506	Towanda	132	27	No	No	NAT	3	2	0	2	7
509	Tree, Lone	121	16	No	No	NAT	3	2	0	0	5
512	Trout	3870	115	Yes	Yes	NAT	2	0	0	0	2
513	Trout, Little	982	91	No	No	NAT	4	1	0	2	7
514	Turtle, North	369	58	Yes	Yes	NAT	4	2	0	2	8
515	Turtle, South	454	23	Yes	Yes	NAT	3	2	0	2	7
516	Twin, North	2782	45	Yes	Yes	NLLC	4	0	0	0	4
517	Twin, South	630	42	Yes	Yes	NLLC	4	0	0	0	4
520	Twin Island	205	14	Yes	Yes	NAT	3	2	0	2	7
523	Van Vliet	220	13	No	Yes	NAT	3	2	0	2	7

COUNTY #64 - VILAS Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
530	Watersmeet	100	12	Yes	Yes	NLLC	3	2	0	2	7
534	Whitefish	196	40		Yes	NAT	4	0	0	0	4
535	Whitney	102	8	No	Yes	NAT	5	2	3	2	12
536	Wildcat	316	35	Yes	Yes	NAT	4	2	0	2	8
544	Wolf	393	28	Yes	Yes	NAT	3	2	0	2	7

COUNTY #65 - WALWORTH

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLET	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Beulah	712	58	Yes	Yes	NLLC	4	1	0	2	7
3	Booth	108	24	Yes	Yes	NAT	3	1	0	2	6
5	Como	1058	8	Yes	Yes	NLLC	5	2	3	3	13
6	Comus	117	8	Yes	Yes	IMP	5	3	3	4	15
8	Delavan	2072	56	Yes	Yes	NLLC	6	0	4	4	14
10	Geneva	5104	135	Yes	Yes	NLLC	2	1	0	2	5
11	Green	292	57	Yes	Yes	NLLC	4	1	0	4	9
16	Lorraine	133	8	Yes	Yes	NAT	5	2	3	2	12
17	Lower Whitewater	137	10		Yes	NAT	5	2	3	3	13
20	Middle	256	42	Yes	Yes	NLLC	4	1	0	2	7
21	Mill	261	44	Yes	Yes	NLLC	4	1	0	3	8
23	North	191	11			NAT	5	2	3	3	13
25	Pell	107	13	Yes	Yes	NAT	5	2	3	2	12
28	Pleasant	138	29	Yes	Yes	NAT	3	1	0	0	4
29	Potters	157	26	Yes	Yes	NAT	5	2	0	5	12
33	Trapp	115	6	Yes	Yes	IMP	1	3	0	2	6
34	Turtle	140	35	Yes	Yes	NLLC	4	1	0	0	5
35	Wandawega	119	9	Yes	Yes	NAT	5	2	3	3	13
36	Whitewater	640	38	Yes	Yes	NLLC	4	1	0	2	7

COUNTY #66 - WASHBURN

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Baker	114	21	No	No	NAT	1	2	3	0	6
5	Balsam	295	49	Yes	Yes	NAT	2	2	0	0	4
8	Bass	128	66	No	No	NAT	2	1	0	0	3
9	Bass	188	35	No	No	NAT	2	1	0	0	3
10	Bass	144	31	No	No	NAT	2	1	0	0	3
12	Bean	100	35	No	Yes	NAT	2	2	0	2	6
18	Big Bass	203	27	No	No	NAT	1	2	0	2	5
19	Big Casey	247	27	Yes	Yes	NAT	1	1	0	2	4
20	Big Devil's	162	75	Yes	Yes	NAT	2	1	0	0	3
21	Big Ripley	190	27	No	No	NAT	1	1	0	0	2
22	Birch	368	73	Yes	Yes	NLLC	2	1	0	0	3
30	Cable	200	24	No	No	NAT	3	2	3	0	8
36	Chicog	125	25	Yes	Yes	NAT	1	1	0	0	2
49	Deer	102	19	Yes	Yes	NAT	1	2	0	2	5
51	De Rosier	109	11	No	No	NAT	5	2	3	0	10
56	Dunn	193	39	Yes	Yes	NAT	2	2	0	0	4
61	Ellsworth	174	6	No	No	NAT	5	2	3	2	12
64	Fenton	139	52	No	No	NAT	2	1	0	0	3
68	Gilmore	389	36	No	Yes	NAT	4	1	0	2	7
76	Gull	511	19	Yes	Yes	NLLC	1	1	0	2	4
85	Horseshoe	194	21	No	No	NAT	1	1	0	0	2

COUNTY #66 - WASHBURN Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
86	Island	276	44	No	No	NAT	2	1	0	2	5
89	Kekegama	109	24	Yes	Yes	NAT	3	2	0	0	5
97	Leesome	146	53	No	No	NAT	2	1	0	0	3
100	Lincoln	101	27	Yes	Yes	NAT	1	2	0	2	5
116	Long	3290	74	Yes	Yes	NLLC	0	2	0	0	2
124	Lower Kimball	129	6	Yes	Yes	NLLC	1	2	0	2	5
125	Lower McKenzie	185	17	Yes	Yes	NLLC	1	2	0	2	5
130	Macrae	124	45	No	No	NAT	2	1	0	0	3
133	Matthews	263	26	No	No	NAT	1	1	0	0	2
136	McKinley	105	23	Yes	Yes	NAT	1	2	0	2	5
137	McLain	150	30	No	No	NAT	1	1	0	0	2
143	Minong Flowage	1564	21	Yes	Yes	IMP	1	2	0	0	3
147	Mud	103	13	Yes	Yes	NAT	1	2	0	2	5
151	Nancy	772	39	Yes	Yes	NAT	2	2	0	2	6
152	Nice	138	11	No	No	NAT	1	1	0	2	4
155	North Twin	113	20	No	No	NAT	1	2	0	0	3
171	Pokegama	453	23	Yes	Yes	NAT	3	2	0	5	10
173	Potato	222	20	No	Yes	NAT	5	2	3	2	12
177	Rice	132	11	Yes	Yes	NAT	3	2	0	4	9
187	Sand	198	9	No	No	NAT	1	2	0	0	3
195	Shallow	137	10	No	No	NAT	5	2	3	2	12

COUNTY #66 - WASHBURN Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
197	Shell	2580	36	No	No	NAT	2	1	0	2	5
200	Silver	188	28	No	No	NAT	1	1	0	0	2
202	Slim	224	42	Yes	Yes	NAT	2	1	0	0	3
203	Slim Creek	101	27	Yes	Yes	IMP	1	1	0	3	5
205	South Twin	115	29	No	No	NAT	1	1	0	0	2
210	Spider No. 5	177	49	No	No	NAT	2	2	0	0	4
211	Spooner	1092	17	Yes	Yes	IMP	5	2	0	6	13
216	Spring	211	24	No	No	NAT	1	1	0	2	4
225	Stone	523	49	No	No	NAT	2	0	0	0	2
236	Tranus	175	12	Yes	Yes	NAT	5	1	3	2	11
237	Trego	451	36	Yes	Yes	IMP	2	2	0	2	6
257	Yellow River Flowage	344	17	Yes	Yes	IMP	1	2	0	3	6
	Unnamed	201	29	Yes	Yes	IMP	3	2	0	2	7

COUNTY #67 - WASHINGTON

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
5	Big Cedar	932	105	Yes	Yes	NLLC	2	1	0	2	5
7	Druid	124	40	Yes	Yes	NAT	2	2	0	2	6
10	Five	102	23	No	No	NAT	5	1	3	3	12
11	Friess	131	51	Yes	Yes	NAT	2	1	0	0	3
26	Little Cedar	259	55	Yes	Yes	NLLC	4	1	0	0	5
42	Pike	522	45	Yes	Yes	NLLC	2	1	0	0	3
47	Silver	119	45	No	Yes	NLLC	2	1	0	0	3

COUNTY #68 - WAUKESHA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
2	Beaver	316	49	Yes	Yes	NLLC	4	1	0	2	7
5	Big Muskego	2260	26	Yes	Yes	NLLC	5	1	3	3	12
10	Denoon	162	60	Yes	Yes	NLLC	4	1	0	3	8
13	Eagle Spring	227	12	Yes	Yes	IMP	1	1	0	3	5
22	Golden	250	46	No	Yes	NAT	4	1	0	3	8
26	Keesus	237	42	No	Yes	NAT	4	1	0	3	8
27	Lac Labelle	1117	47	Yes	Yes	NLLC	4	2	0	4	10
32	Little Muskego	518	65	Yes	Yes	NLLC	6	1	0	5	12
36	Lower Nemahbin	271	36	Yes	Yes	NLLC	4	1	0	0	5
37	Lower Phantom	433	12	Yes	Yes	NLLC	3	1	0	5	9
39	Middle Genesse	102	38	No	No	NAT	2	1	0	0	3
45	Nagawicka	917	90	Yes	Yes	NLLC	4	2	0	7	13
47	North	437	78	Yes	Yes	NAT	4	1	0	0	5
48	Oconomowoc	767	62	Yes	Yes	NLLC	4	1	0	3	8
49	Okauchee	1187	94	Yes	Yes	NLLC	2	0	0	2	4
51	Pewaukee	2359	45	Yes	Yes	NLLC	4	2	0	9	15
52	Pine	703	85	Yes	Yes	NAT	4	1	0	2	7
61	Silver	222	44	Yes	Yes	NAT	4	1	0	0	5
63	Spring	100	20	Yes	Yes	NAT	3	1	0	0	4

COUNTY #68 - WAUKESHA Con't

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
70	Upper Nashotah	133	53	No	Yes	NLLC	4	0	0	0	4
71	Upper Nemahbin	283	61	Yes	Yes	NAT	4	1	0	2	7
73	Upper Phantom	111	29	Yes	Yes	NLLC	3	1	0	2	6

COUNTY #69 - WAUPACA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
4	Bear	194	62	Yes	Yes	NAT	2	1	0	2	5
22	Long (Chain)	104	75	Yes	Yes	NAT	4	1	0	0	5
32	Rainbow (Chain)	116	95	Yes	Yes	NAT	4	1	0	0	5
38	Cinco Bayou	169	4	Yes	Yes	NAT	5	3	3	3	14
55	Hatch	112	13	Yes	Yes	NAT	5	2	3	0	10
60	Iola Millpond	206	11	Yes	Yes	IMP	3	3	0	3	9
79	Manawa	195	12	Yes	Yes	IMP	3	3	0	3	9
80	Marion Millpond	109	11	Yes	Yes	IMP	5	4	3	5	17
104	Partridge	1124	6	Yes	Yes	NAT	3	3	0	2	8
105	Partridge Crop Bayou	238	8	Yes	Yes	NAT	3	3	0	2	8*
109	Pigeon-Clintonville	218	12	Yes	Yes	IMP	5	3	3	5	16*
142	Weyauwega	274	11	Yes	Yes	IMP	3	3	0	4	10*
143	White	1026	11	No	No	NLLC	5	3	3	3	14

COUNTY #70 - WAUSHARA

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Auroraville Millpond	209	6	Yes	Yes	IMP	5	2	3	3	13
22	Fish (Wautoma)	289	5	No	Yes	NLLC	5	2	3	3	13
23	Fish (Hancock)	177	42	No	No	NAT	2	1	0	0	3
26	Gilbert	141	65	No	No	NAT	2	1	0	0	3
27	Hills, Big	135	20	No	No	NAT	3	1	0	2	6
39	Long (Saxeville)	272	71	No	No	NAT	0	1	0	0	1
47	Mount Morris	163	40	Yes	Yes	IMP	2	1	0	6	9
56	Pine (Hancock) Pike	163	15	No	No	NAT	5	1	3	9	18
57	Pine (Springwater)	143	48	No	No	NAT	2	1	0	0	3
60	Pleasant	127	30	No	No	NAT	1	1	0	0	2
70	Silver	328	46	No	No	NAT	2	1	0	0	3
86	White River (Lower)	110	22	Yes	Yes	IMP	1	1	0	2	4

COUNTY #71 - WINNEBAGO

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLT	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Butte Des Morts	8857	11	Yes	Yes	NAT	3	3	0	4	10
2	Little Butte Des Morts	1306	12	Yes	Yes	NAT	5	3	3	4	15
5	Poygan	14102	11	Yes	Yes	NAT	3	3	0	4	10
6	Rush	3070	16	No	No	NAT	5	2	3	3	13
7	Winnebago	137708	21	Yes	Yes	NLLC	3	3	0	7	13
8	Winneconne	4507	10	Yes	Yes	NAT	3	3	0	4	10

COUNTY #72 - WOOD

LKNO	LAKE NAME	AREA	MXD	INLET	OUTLET	TYPE	D.O.	TRNS	FSKL	IMPR	LCI
1	Biron Flowage	2126	23	Yes	Yes	IMP	1	3	0	2	6
2	Centralia Flowage	231	19	Yes	Yes	IMP	1	3	0	2	6
3	Lake Dexter	300	14	Yes	Yes	IMP	1	2	0	0	3
4	Nekoosa Flowage	452	17	Yes	Yes	IMP	3	3	0	2	8
5	Nepco	494	29	Yes	Yes	IMP	3	1	0	3	7
6	Port Edwards Flowage	117	16	Yes	Yes	IMP	1	3	0	2	6
8	Wazeecha	148	23	Yes	Yes	IMP	3	3	0	3	9
9	Wisconsin Rapids Flowage	447	22	Yes	Yes	IMP	1	3	0	2	6
24	South Gallagher Flowage	395	6	Yes	Yes	IMP	5	3	3	2	13

APPENDIX II

NOTES REGARDING STATE LAKE INVENTORIES

ALABAMA:	Reservoirs greater than 500 surface acres only.
CALIFORNIA:	Dams within the jurisdiction of the state.
COLORADO:	Estimate prepared by Water Resources Center (WRC) staff from United States Geological Survey (USGS) maps. Figures given do not include intermittent lakes.
DELAWARE:	Estimate of number of lakes greater than 100 surface acres obtained from state agency official.
GEORGIA:	Estimates obtained from state agency official.
ILLINOIS:	Lakes less than 6 acres have also been inventoried and represent 96.7% of the number of lakes in the state, but only 20.4% of the acreage.
KANSAS:	Major reservoirs and selected city impoundments have been inventoried. Estimate of number of lakes greater than 100 surface acres obtained from state agency official.
KENTUCKY:	Computerized inventory conducted; printouts are available. Estimate of number of lakes greater than 100 surface acres obtained from state agency official.
LOUISIANA:	Estimate prepared by WRC staff from USGS maps. Approximately 55-60% of the state's lakes are located in the coastal marshes of the Gulf of Mexico.
MAINE:	Estimate of the number of lakes greater than 100 surface acres obtained from state agency official.
MARYLAND:	Estimate prepared by WRC staff from USGS maps. Of this number, approximately 50% are located in coastal marshes.

MICHIGAN:	Computerized inventory conducted; printouts are not readily available.
MISSISSIPPI:	Estimate prepared by WRC staff from USGS maps.
MISSOURI:	State has information in map form only. The estimate given in Table 6 was prepared by WRC staff from USGS maps.
MONTANA:	Estimate prepared by WRC staff from USGS maps. Figures given do not include intermittent lakes.
NEBRASKA:	Only the sandhills area of the state has been inventoried. Estimate of number of lakes greater than 100 surface acres obtained from state agency official.
NORTH CAROLINA:	State has published a register of dams and dam sites. The estimate of the number of lakes greater than 100 surface acres was obtained from state agency official.
NORTH DAKOTA:	Estimate prepared by WRC staff from USGS maps. Figures given do not include intermittent lakes.
OREGON:	3,743 of the 6,435 lakes listed are unnamed.
PENNSYLVANIA:	Computerized inventory conducted; printouts are available.
TEXAS:	Reservoirs with greater than 5,000 acre-feet storage capacity only.
VIRGINIA:	Only major reservoirs have been inventoried. Estimate of number of lakes greater than 100 surface acres obtained from state agency official.
WEST VIRGINIA:	There appears to be only one natural lake of appreciable size in the state; the remainder are reservoirs. Estimates obtained from state agency official.
WISCONSIN:	The state's inventory includes all named lakes regardless of size. A partial inventory of unnamed lakes includes 4,803 additional entries.

WYOMING: Computerized inventory conducted; printouts not readily available. The estimate of number of lakes greater than 100 surface acres obtained from state agency official.

APPENDIX III

LAKE INVENTORY QUESTIONNAIRE

STATE: ____________________ SURFACE AREA: ____________ Acres

COUNTY: ____________________ MAXIMUM DEPTH: ____________ Feet

LAKE NUMBER: ______________ *MEAN DEPTH: ______________ Feet

LAKE NAME: _______________ LOCATION:

____

Township	Range	Section
________	_____	_______

*Mean depth is defined as:
VOLUME/SURFACE AREA (ACRE FEET/AREA).

LAKE TYPE:

	Yes	No	Do not know
Does the lake have an: Inflowing stream?	___	___	______
Outflowing stream?	___	___	______

Is the lake an:

Impoundment?	___
Natural lake?	___
Natural lake with level control?	___
Do not know.	___

THERMAL STRATIFICATION:	Yes	No
Is the lake ice-covered during the winter?	___	___

Which of the following best describes the thermal stratification in the lake?

Lake is permanently stratified.	___
Lake undergoes one period of mixing annually.	___
Lake undergoes two periods of mixing annually.	___
Lake undergoes frequent mixing.	___
Lake undergoes continuous mixing.	___
Do not know.	___

LAKE CLASS:

Check one of the following classes *if* it applies to the lake:

Bog: Brown-stained water is the key characteristic; dystrophic; acid, pH typically 6 or less; encroaching leather-leaf bog, usually floating.. ____

Marsh lake: Clear water; shallow, not stratified; alkaline, pH typically 7 or more; encroaching grassy marsh vegetation............. ____

Alpine lake: Lake occupying a depression in a high mountainous region; rock or gravel bottom usually; dissolved oxygen abundant at all times in ice-free season, hypolimnion seldom falling below 80% saturation; generally unproductive lakes.. ____

Flow-through reservoir: An impoundment with a hydraulic residence time of less than one year (i.e., the ratio of the total volume to the annual inflow is less than one)................. ____

If one of the foregoing classes is checked, skip the following section and continue with LAKE CONDITION.

If the lake is not described by one of the foregoing classes, mark the appropriate class below:

Warmwater fisheries: If stratified, the lake contains an insignificant amount of dissolved oxygen in the hypolimnion (bottom waters) to support fish life in late summer; major portion of lake is open water; shoreline encroachment is slight compared to open water; contains typical warmwater fish populations, including largemouth bass, bluegills, northern pike, and/or yellow perch............................ ____

Warm- and coldwater fisheries: Deeper, stratified; at least 4 feet of water in the hypolimnion which contains 4 ppm dissolved oxygen in late summer; contains a population of warmwater fish and may or may not contain a population of trout.......................... ____

Coldwater fisheries: Deep, infertile; an abundance of well oxygenated water in the hypolimnion; well suited to trout and cisco, may or may not contain these species exclusively....... ____

LAKE CONDITION:

Check the appropriate level of each of the following parameters defining the lake's condition.

Dissolved oxygen:

Dissolved oxygen in hypolimnion, bottom waters, greater than 5 ppm at virtually all times.................................... ___

Concentrations in hypolimnion less than 5 ppm but greater than 0 ppm....................... ___

Portions of hypolimnion void of oxygen at times.................................... ___

Entire hypolimnion void of oxygen at times.... ___

Do not know................................. ___

Alkalinity:

Low: 0 - 50 ppm $CaCO_3$................. ___

Medium: 50 - 100 ppm $CaCO_3$................. ___

High: > 100 ppm $CaCO_3$................. ___

Do not know................................. ___

Specific conductance:

Low: 0 - 75 µmhos @ 25°C.............. ___

Medium: 75 - 200 µmhos @ 25°C.............. ___

High: > 200 µmhos @ 25°C.............. ___

Do not know................................. ___

Transparency:

Transparency, as indicated by the Secchi Disk depth, should be expressed here as a typical minimum and maximum range.

	Minimum	Maximum
0 - 1.5 ft (0 - 0.5 m)..........	___	___
1.5 - 10 ft (0.5 - 3 m)..........	___	___
10 - 23 ft (3 - 7 m)..........	___	___
> 23 ft (> 7 m)..........	___	___
Do not know.........................	___	___

SHORELINE DEVELOPMENT:

What is the length of the lakes's shoreline? ________miles

Estimate the percent of shoreline which is developed (occupied by improvements)........ ________%

Estimate the percent of shoreline which is under the following ownership:

Public........ ________%

Private....... ________%

LAKE USE:

Mark the appropriate use(s) of the lake.

Municipal water supply........................ ______

Industrial water supply........................ ______

Agricultural water supply...................... ______

Flood control.................................. ______

Low-flow augmentation.......................... ______

Power.. ______

Recreation..................................... ______

Other (specify) ______________________________ ______

LAKE PROBLEM:

Mark the appropriate problem(s) which exist(s) in the lake.

Excessive aquatic weed growth.................. ______

Nuisance algal growth.......................... ______

Fishkills...................................... ______

Bacterial contamination........................ ______

Unstable water levels.......................... ______

Excessive sediment accumulation................ ______

Excessive dissolved solids..................... ______

Taste and/or odor in water supply.............. ______

No problem..................................... ______

Other (specify) ______________________________ ______

IMPAIRMENT OF USE:

Check the category which most closely describes the lake condition.

No impairment of use

Very few algae present, no "bloom" conditions
AND/OR
Very few weeds in littoral zone................ _____

Slight impairment of use

Occasional "blooms," primarily green species of algae
AND/OR
Moderate weed growth in the littoral zone....... _____

Periodic impairment of use

Occasional "blooms," predominantly bluegreen species
AND/OR
Heavy weed growth in littoral zone.............. _____

Severe impairment of use

Heavy "blooms" and mats occur frequently, bluegreen species dominate
AND/OR
Excessive weed growth over entire littoral zone. _____

PREVIOUS CORRECTIVE TREATMENTS:

Have any rehabilitative treatments been undertaken in the past or at the present time to improve the lake? If so, which of the following types?

Mechanical harvesting of plant growths.......... _____
Chemical control of weeds or algae.............. _____
Flushing.. _____
Dredging.. _____
Waste water diversion........................... _____
Nutrient removal from waste waters.............. _____
Hypolimnetic withdrawal......................... _____
Water level management.......................... _____
Nutrient immobilization or precipitation........ _____
No treatment.................................... _____
Other (specify)________________________________ _____

BACKGROUND DATA:

For purposes of this inventory, three data categories have been chosen: physical, chemical, and biological. To account for variations in completeness of data among these categories, the system of rating has been designed to treat each of the three categories separately:

	Phys	Chem	Biol
No record or only scattered measurements..........................	____	____	____
Partial data: continuous monitoring on a limited scale; long-term sampling program of low frequency; data probably not adequate to document a change if renovation were undertaken.........	____	____	____
Extensive data: intensive monitoring program covering a variety of locations and depths; frequent sampling for a duration of two years or more; sufficient to document a change if renovation were undertaken............	____	____	____
Do not know..........................	____	____	____

Is there a nutrient budget available for the lake?

Measured.................................... ____

Estimated.................................... ____

Do not know.................................. ____

DRAINAGE AREA:

What is the size of the lake's direct drainage area?

The direct drainage area is defined as that portion of the total drainage area which does not drain to upstream lakes or impoundments.

__________square miles

Estimate the percent of the direct drainage area devoted to the following uses.

Urban.. _____%

Agricultural................................. _____%

Rural non-agricultural....................... _____%

Other (specify) ________________________________ _____%

________________________________ _____%

POTENTIAL SOURCES OF POLLUTANTS (NUTRIENTS):

Indicate below the potential sources of pollutants (nutrients) within the direct drainage area which may enter the lake. Check as many as are appropriate to describe the potentially significant inputs to the lake.

Domestic:

Septic tanks.................................. ____

Municipal effluents: Untreated................ ____

Primary treatment........ ____

Secondary treatment...... ____

Estimate the total population contributing to each effluent type:

Untreated........... ________

Primary treatment... ________

Secondary treatment. ________

Agricultural:

Cultivated land............................... ____

Pasture....................................... ____

Animal feedlots............................... ____

Irrigation return flows....................... ____

Industrial:

Industrial effluents (treated or untreated)... ____

Urban runoff:

Storm drainage, etc. .... ____

Other (specify): ______________________________ ____

______________________________ ____

Form completed by: ____________________
(Initials)